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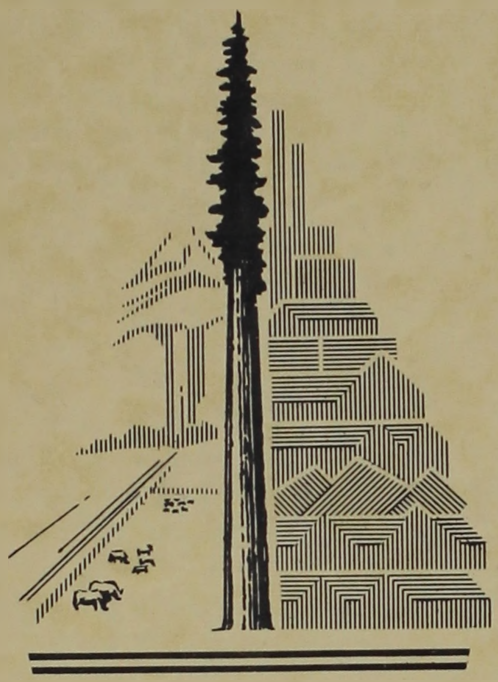

U. S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE
PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
R. W. COWLIN. DIRECTOR

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ANNUAL REPORT OF THE
PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
FOR THE CALENDAR YEAR 1952

INTRODUCTION

During 1952 the station followed through on plans to review critically its research program. Both short-range and long-range projects and proposals were scrutinized. Special attention was given to strengthening and coordinating cooperative research with other agencies. Looking back, tangible progress was made in these efforts and ground work was laid for continuing progress in making the station's program more effective.

Interruptions of personnel resulting from military leave, educational furloughs, and transfers were not as serious as in previous years. Defense projects became a negligible item in the station's program by early 1952. Looking ahead to a year of concentrated research, a thoroughgoing review of the station's programs was scheduled early in March. The Regional Investigative Committee met at that time under the chairmanship of Regional Forester Stone. In addition to the station, regional office, and national forest personnel, representatives from other Federal departments and bureaus having forest and range land responsibilities were invited and participated in the discussions. Each project was reviewed critically and profitably. From the presentations and discussion of the meeting the station received positive help in appraising the effectiveness and balance of its program, past and future. Gaps and lack of strength in certain fields of work such as forest influences, forest soils, forest genetics, the slash disposal phase of forest management, and fire research were emphasized.

Another arm of program review was not neglected--a technical advisory committee for the Puget Sound Research Center was organized and the first meeting held at Olympia, Wash., in February. Three additional meetings of this group were held later in the year. Encouraged by the success of this committee a similar group was organized for the Deschutes Research Center in central Oregon and the initial meeting held in October. The station is planning on organizing advisory committees at other research centers at appropriate times.

In addition, the station joined with the Pacific Northwest Region in the selection and organization of a Regional Forest Service Advisory Council. This council, composed of exceptionally well-qualified men from major geographic and economic segments of the region, held two meetings during the year. The first meeting was held in Portland in July and the second at Wind River in October. This group functions on a broad policy basis only. A regional technical advisory group may be organized during 1953 and a regional technical advisory committee within the coming year.

Another step in the direction of economy of research manpower and improvement of the effectiveness of our work programs was taken during the year through thorough critical reviews by the director and his Portland office staff of the work at the field stations. Such comprehensive inspections were made of the Puget Sound, Deschutes, and Siskiyou-Cascade Research Centers and Wind River Experimental Forest. It is planned to complete inspections of the remaining field stations during 1953. Thereafter such inspections will probably be made at three- or four-year intervals.

In forest management research, with all but one of the station's 11 experimental forests active, tangible results of earlier work are showing up. For example, there is positive evidence that wind damage associated with clear cutting can be greatly reduced. In direct seeding what may be a significant development was introduction of tetramine--a combined rodent repellent and rodenticide. Evidence is mounting that commercial thinning is profitable, both economically and silviculturally, on better sites in young-growth Douglas-fir beginning at ages 30 to 40 years. Although little work is under way in forest genetics, interest in this important field is rapidly growing and progressive forest managers are demanding answers to questions regarding genetical improvements of our forests.

Revival of forest mensurational studies is producing improved techniques in constructing taper and volume tables and growth estimates.

The return of Robert F. Tarrant about midyear from Navy service reactivated the soils research program. Work on the effect of slash fires on forest soils soon picked up momentum. A major part of Tarrant's time will be devoted to this critical problem. A short-term study in cooperation with Washington State College resulted in the development of a reconnaissance method for classifying forest soils.

High points of grazing management studies were revision of the study plan and substantial progress toward completion of the necessary physical installation at the Starkey Experimental Range. In range reseeding it was found that light mulches of sawdust or sheep manure are effective in protecting grass seedling stands from frost heaving on scab ridges. Species adaptability tests are giving useful answers and will be continued at both the Blue Mountain and Mid-Columbia Research Centers. Overshadowing the work in range research was the transfer of J. F. Pechanec, Chief, Division of Range Research, at the end of the year to replace W. R. Chapline in charge of the Washington Office Division of Range Research. The severity of this loss upon our range research program was mitigated by the availability of David F. Costello to replace him, a well-trained and effective team of range research men at the field stations, and a carefully planned program of work.

Major work in flood control surveys was concentrated on coordination and continuation of flood control phases and related phases of

the Columbia Basin Agricultural Program. Responsibility for the Willamette subwatershed unit of the Columbia Basin report and flood control surveys for the rest of western Oregon was transferred from the California station to this station. Other phases of the basin program received attention of flood control and other station personnel.

One of the milestones in the station's history was the start of forest influences studies with the addition of E. G. Dunford to the station staff late in the year. Actually, some work in water studies has been under way and during 1952 stream gages were installed at the Blue River Experimental Forest on three small watersheds, the first such permanent installation in the Pacific Northwest. Previously watershed studies have been on a minor scale. Now they assume independent stature.

The expanded use of sawmill and plywood wood residues for production of pulp and hardboard was a notable advancement in wood utilization. This event is important to foresters because of the relief it gives to pressures upon young-growth stands for supplying pulpwood needs. This has beneficial and adverse aspects; while it may limit premature or wasteful cutting of such stands, it also limits markets for improvement thinnings.

Forest Survey findings in western Washington continue generally to support the trend reported for southwestern Oregon. Saw-timber volumes show an apparent increase resulting partly from more intensive utilization and partly from passage of large areas into saw-timber size stand class. Conversely, volume of the growing stock--trees 6.0 inches and larger--is declining. During the year a major impact upon the Forest Survey staff was the undertaking of the emergency Douglas-fir blowdown and bark-beetle loss survey under station leadership. Planning for the Nation-wide Timber Resource Review was another new undertaking.

The preceding paragraphs contain but a fragmentary account of the station's accomplishments and program and are not intended to be a synopsis. The purpose of this introduction is to illustrate the dynamic nature of the forest situation in this region, to point out that application of forest and range management findings is progressive, and to reaffirm our intentions of answering the demand for enlightened methods of resource management with all the means we can command. The record of our past year follows in appropriate detail.

FOREST ECONOMICS

Special defense activities were not a major feature of the work of the Division of Forest Economics during 1952. In comparison with 1951, there was a great falling off in urgent requests for special resource or industry information.

A special job developed in the spring that had a material impact on work of the division. By April of 1952 it was apparent that a serious infestation of Douglas-fir bark beetle was developing, particularly in western Oregon. The station was requested to survey the extent and character of this infestation. This Blowdown-Bark Beetle Survey, locally called BDBB, is discussed in more detail in a later section.

The scheduled Nation-wide Timber Resource Review received some attention from division personnel during the year, and will receive more during the coming two years.

Forest Survey

The field phase of forest survey reinventories progressed at a reasonably satisfactory rate during the year. The total area covered was approximately 2,541,000 acres of forest land. This work included completing Lewis County, Washington, the western one-third of which was done in 1951, and starting and completing reinventories of Clatsop and Crook Counties in Oregon. Crook is the third county in the ponderosa pine subregion to receive an initial reinventory. Klamath County was reinventoried in 1946 and Lake County in 1947.

The county type maps of Skamania and Mason Counties, Washington, were drafted and made available, through reproduction by commercial blueprinting firms, to the public. Drafting of the type map for Grays Harbor County was very near completion at the end of the year and preparation of the base map for Lewis County was well along. Projection of type data from aerial photos to the county base maps was completed for Mason and Grays Harbor Counties, Washington, and partially completed for Lewis County, Washington, and Clatsop County, Oregon.

The office computation of type areas by ownership class was finished for all of Grays Harbor and Mason Counties and a third of Lewis County. Computation of the timber-volume, growth, and mortality data from the randomly selected field plots was completed for the first two of these counties and started for the latter county.

Statistical reports presenting results of reinventories made in 1949 were prepared and published for Cowlitz and Wahkiakum Counties, Washington. These are: Forest Survey Report No. 105, "Forest Statistics for Cowlitz County, Washington," and Forest Survey Report No. 106, "Forest Statistics for Wahkiakum County, Washington." The report for

Cowlitz County shows that although cutting drain has been quite consistently large-scale during the past 25 years, there remain some 21 billion board feet, log scale, Scribner rule, of saw-timber volume in the county. This volume compares with some 15.9 billion board feet according to the 1939 reinventory, and with 18.6 billion board feet at the time of the initial inventory in 1933. In Wahkiakum County, one of the smaller counties in western Washington and one in which forest utilization has been relatively heavy for a similar period, the report shows a saw-timber volume of 2.7 billion board feet. By comparison, the 1940 reinventory showed 2.2 billion board feet, and the initial inventory in 1931 showed 2.4 billion board feet.

By contrast with these increases in board-foot volumes of saw timber, there was a decrease of about 19 percent in each county in cubic-foot volume of growing stock, a classification which includes both live saw-timber trees and pole-timber trees. The increases in board-foot volume of saw timber were partly due to the sizable acreages of young-growth stands which grew into the saw-timber-size class during the interval, but only in part. A large part of the increase was due to significant differences in specifications and standards adopted for the successive surveys, differences which reflect the more intensive woods utilization of recent years. On the other hand, there were fewer changes in specifications between the respective inventories for volume of primary growing stock, which is the volume category measured in cubic feet.

Also prepared for release at the end of the year was a slightly revised edition of a booklet, "Forest Type Classification for the Pacific Northwest Region." This booklet, first released in 1949, presented a forest type classification cooperatively designed by the station's Division of Forest Economics and the regional office Division of Timber Management. This classification has been accepted and used by a number of public agencies and private corporations and an original printing of 1,000 copies of the booklet has been entirely depleted.

The division cooperated with the office of the State Forester of Oregon in designing a survey involving type classification and detailed type mapping and timber-volume sampling on about 150,000 acres of State-owned forest land in Clatsop County. The results of this type mapping were used in the 1952 reinventory of Clatsop County.

Special attention was given during the year to obtaining information on the extent and character of unutilized logging residuals left on current logging operations in the region. A cooperative sampling survey was made of current operations in western Oregon and plans were developed to adapt results of a similar survey in the State of Washington made in 1949-50 by that State's Institute of Forest Products. The survey of recently logged areas in western Oregon was conducted cooperatively with the Oregon Forest Products Laboratory, Corvallis, Oreg. The unutilized material was measured and classified on a total of 100 randomly selected plot clusters, consisting of three one-half-acre

subplots each. The division measured 60 of the plot clusters, the laboratory 40. Computation and analysis of the field data were near completion at the end of the year.

Cooperative Blowdown-Bark Beetle Survey

During the early part of 1952 it became apparent that a serious epidemic of the Douglas-fir bark beetle was shaping up. During February and March a joint aerial reconnaissance survey was made by the U. S. Bureau of Entomology and Plant Quarantine's Portland Forest Insect Laboratory, the Oregon State Board of Forestry, and the Weyerhaeuser Timber Company. This survey found that there was detectable infestation on somewhat over 3 million acres in western Oregon and a small portion of southwestern Washington. It was known that during the winter of 1951-52 there had been storms especially over the Coast Range of Oregon which had produced a substantial amount of blowdown. It was apparent to entomologists and others who had followed the course of events that a serious situation was in the making.

Through efforts of the Insect Laboratory and the Forest Service regional office here, as well as through efforts of the Northwest Forest Pest Action Committee, this development was called to the attention of the Washington offices of the Forest Service and of the Bureau of Entomology and Plant Quarantine. Early in May, the Division of Forest Economics was instructed to collaborate with the Portland Forest Insect Laboratory in formulating plans for and carrying out a survey to determine the location and extent of the acreage and volume involved in this infestation.

Direct control of the beetles is considered infeasible because bark beetles cannot be controlled by generalized spraying and the cost of felling and treating each infested tree would be exorbitant. However, removal of fire-killed or blown-down timber before it is infested or while beetles are still in it has definite control effects. Consequently, an additional purpose of the survey was considered to be obtaining information on the location of the infestation rapidly and getting that information promptly into the hands of forest landowners and forest land managers who could influence the start of salvage logging.

Results of the survey showed that there were 201,800 acres of blowdown that occurred during the winter of 1951-52 of a sufficiently concentrated character so that it could be identified and mapped from the air. The results also showed that a net volume of almost exactly 1 billion board feet, log scale, had been killed by beetles up to the time of the survey in July. The net volume of timber blown down in the storms of the winter of 1951-52 totaled 8.9 billion board feet, log scale. Of this volume, 7.4 billion board feet occurred as scattered individual trees and small groups, important as a springboard for further spread of the infestation but mostly too scattered to form a basis for salvage logging.

Further heavy killing may be expected even without additional blowdown. It is not unreasonable to expect that an additional 5 billion board feet will be damaged.

The technique used in this survey was built around flying mappers who mapped the location of blowdown and beetle kill, supplemented by ground cruisers who measured survey plots to sample the various classes of blowdown. The survey did not use aerial photographs. Airplanes used were all four-place Cessna 170-B's, which were selected because of their maneuverability, their ability to fly slowly but safely, and their good visibility characteristics. Prior to flying, maps were prepared on which flight lines to be flown were laid out either at one-mile intervals, two-mile intervals, or on the contour. Crew members had identical maps of the area the crew was to fly each day. It was the job of the pilot to fly the flight line and do it safely. The man sitting beside the pilot in the front seat mapped beetle-kill groups. The two men in the rear seat of the plane mapped blowdown, each man mapping on his side.

Since a purpose of the survey was to get this detailed information as quickly as possible into the hands of landowners and land managers, the job was only partly done when the flying had been completed. As the flying mappers completed each map, draftsmen took over and prepared the maps for publication. Published maps were placed in the hands of those who could make effective use of the information by early October. A 10-page summary entitled "Summary Statement on the 1952 Blowdown-Bark-Beetle Survey in the Douglas-Fir Region of Oregon and Washington" was published in late October. This statement briefly summarized the findings of the survey and showed by generalized maps the location of the infested areas and also of the 1951-52 blowdown. A final report on the project was in preparation at the end of the year.

This was a fully cooperative project, under the over-all leadership of the station's Division of Forest Economics. The planning and supervision were done jointly by the Portland Forest Insect Laboratory and by the Division of Forest Economics. Personnel assigned to the project totaled 36 and came from the Forest Insect Laboratory, from Region 6 of the U. S. Forest Service, from Region 1 of the Bureau of Land Management, from the Oregon State Board of Forestry, from the Industrial Forestry Association, from the Willamette Valley Tree Farm Management Service Inc., from the U. S. Weather Bureau, and from the Pacific Northwest Forest and Range Experiment Station. In addition, Region 7 of the Soil Conservation Service multilithed the maps, and valuable aid in the preparation of reports was received from the Industrial Forestry Association.

The project cost approximately $83,000, of which $10,000 was contributed in cash by the Oregon State Board of Forestry. Approximately $11,000 came in services and salaries contributed by the various organizations participating, including time and transportation of four men

donated outright for the entire project by the Oregon State Board of Forestry. The balance, approximately $62,000 came from pest control funds appropriated to the U. S. Forest Service and allotted to the station for this survey.

This blowdown-bark-beetle survey had, unfortunately, some unavoidable impact on the regular work of the Forest Survey organization. Three key people from the division spent the bulk of their time during the summer and fall on this project. One field man was used as an aerial observer, and others from the division were used at different times in helping to plan or to execute especially difficult parts of the job.

Work on this project that should be done in 1953 is discussed in the following section.

Plans for 1953

During the first three or four months of the year it is planned to complete all phases of the office work of the reinventories of Lewis, Clatsop, and Crook Counties. Also scheduled are the completion and release of the 1-inch county forest type maps for these three counties and Grays Harbor County.

As rapidly as the work can be fitted in, it is planned to publish county statistical reports for Skamania, Clark, Pacific, Grays Harbor, Mason, Lewis, Clatsop, and Crook Counties.

Inventory field work is planned for Deschutes and Jefferson Counties in Oregon, and probably Kittitas County in Washington. If time permits, it would be desirable to cover one additional county east of the Cascade Range, the choice depending upon availability of satisfactory aerial photography.

Completing computations for volumes of net growth and mortality in recently reinventoried counties is another project scheduled for completion this year. Release of this information in published form will probably be through county-group reports. This information will form the basis for revised growth estimates for the two States and two subregions for the Timber Resource Review.

It is planned to conduct further studies in aerial photo mensuration. This will include complete revision and improvement of photo-volume tables and analysis of the sampling scheme involving photo-volume plots to determine when and how it is best applied.

The schedule of work here outlined will keep regular Forest Survey work going at a normal level and will permit developing summaries for the two subregions and the two States in accordance with plans for the inventory, growth, and depletion phases of the Nation-wide

Timber Resource Review. During the coming fall and winter especially, organization of office work will be pointed toward developing statistics and summaries needed for this review.

Some additional work will have to be done as a necessary follow-up to last summer's survey on the Douglas-fir bark beetle epidemic. Some infestation centers have been discovered in western Washington which did not show at the time of the July survey. It is probable that the perimeter of the infestation area will change. It is certain that the intensity of the infestation in different parts of the infested area will change from that which prevailed in the mid-summer of 1952.

It will not be necessary to repeat a survey on the detailed basis of the 1952 survey. It will be necessary to make a reconnaissance type survey over much of the area covered in 1952, using techniques roughly comparable to those used in the ordinary insect detection survey as conducted by the Portland Forest Insect Laboratory. In addition, both further ground checking and further work in taking colored photographs of plot areas for study of changes in conditions will be needed.

FOREST UTILIZATION SERVICE

The trend toward better utilization of timber resources of the Pacific Northwest continued during the year. Perhaps the most significant development was the greatly expanded use of mill and plywood residues for production of pulp and hardboard. Formerly sulfate pulp companies obtained most of their raw material from Douglas-fir logs and pulpwood. Now they have nearly replaced the log and pulpwood requirements by chips from mill residues that would otherwise have been burned. The decreased demand for Douglas-fir pulpwood has somewhat curtailed the amount of cutting in small immature timber. Oregon and Washington now have 10 hardboard plants in operation or under construction. The rated capacity of these plants is approximately 450 million square feet of 1/8-inch board per year. It is encouraging to note that all of this production is based on a raw material supply otherwise unutilized and will cause no additional drain on the region's forest resources.

In an effort to solve wood utilization problems of the Pacific Northwest the Forest Utilization Service unit continued this year to present them to the Forest Products Laboratory for investigation, to bring the results of research and technical knowledge at the Laboratory to the wood-using industries and timber owners in the region, and to cooperate with research laboratories, individuals, companies, and organizations in the area in the promotion of better use of wood. Some of the utilization problems receiving attention are summarized in this report.

Raw Material for Pulp Mills

Encouraging progress was made by the pulp industry in utilizing mill residues as raw material, thereby lessening the demand for logs suitable for lumber and other similar products. For the year 1950 Oregon and Washington pulp mills used approximately 737 million units of chips, which was 16 percent of their raw material supply. This volume of residual wood replaced approximately 320 million board feet of logs. It is estimated that during the two years since 1950 use of chips obtained from mills has about doubled.

Pulp companies began to use logs of species having little previous commercial value. During the past year three companies started using red alder and one company brought in lodgepole pine from Idaho. A few years ago large quantities of low-grade Douglas-fir logs and pulpwood from immature stands were being used but now pulp chips from sawmills and plywood plants have almost entirely replaced the demand for this type of logs and pulpwood. Although the volume of Douglas-fir pulp chips could be greatly expanded, it will not be possible without new markets.

The trend in utilizing pulp chips may prove both beneficial and detrimental. It has decreased clear cutting of small, rapidly growing immature timber. On the other hand, it lessens the chance to practice good forest management on areas cut. Markets for selling pulpwood obtainable from thinnings and low-quality Douglas-fir logs are now rather poor. Good forest management is not possible without markets that will justify close utilization. This region has sufficient raw material to support a considerable increase in the sulfate pulp capacity.

Hardboard Production

Hardboard, the newest wood-using industry in the Pacific region, continues to expand. The first board plant in the Northwest was built in 1945; there are now 10 plants in operation or under construction. These plants have an annual capacity of 450 million square feet of 1/8-inch hardboard about evenly divided between the wet-process and the dry-process. All the plants will be operating on material that would otherwise be wasted. One plant will operate on cull white fir timber while all the rest will use either sawmill or plywood residues. In addition to the above plants there are three more in the planning stage with an estimated capacity of 120 million square feet.

To produce the 450 million square feet of hardboard about 164 million units of chips will be required, which is the equivalent of a little over 71 million board feet of logs.

Seasoning

Kiln drying young-growth Douglas-fir. A study aimed at improving the kiln drying of common grades of Douglas-fir lumber produced from

young, small trees was started during the year. The Forest Service studied the kiln drying of boards and dimension produced from old-growth Douglas-fir about 30 years ago when the internal-fan kiln was being developed by the Forest Products Laboratory. That study showed that common grades of lumber could be successfully dried to a moisture content of 18 to 20 percent and the Douglas-fir industry adopted and has adhered to this standard. If the lumber was dried to lower moisture contents, it was found that considerable loosening of the knots developed, causing them to drop out in machining, thereby degrading the lumber. Drying to 18- to 20-percent moisture levels eliminates the problem of stain and decay in storage and use and eliminates approximately half of the shrinkage between unseasoned and seasoned wood. While the consumer accepts this standard of dryness, he often desires more fully dried and pre-shrunk lumber for building, especially where additional shrinkage after framing is objectionable.

Improvements in kiln equipment and performance during the past 30 years and a better understanding of how lumber dries may now permit the development of better drying schedules and procedures. It may be possible to commercially kiln dry some types of common lumber to lower moisture content levels before machining and shipping to the consumer. This is particularly true of the large volume of lumber now cut from second-growth stands which have much smaller and more highly intergrown knots than those in old-growth timber.

A study now under way is designed to measure the effects of drying tight-knotted Douglas-fir dimension to moisture levels of 18, 15, and 12 percent. Information will be obtained on: (1) the fall-down in grade which develops when drying the lumber to each of these moisture levels and then machining it to standard sizes, (2) the effect of drying on the shipping weight of rough and surfaced lumber, and (3) the amount of shrinkage which develops in drying before machining as well as the shrinkage which takes place when the lumber undergoes additional drying after framing the building. Principal attention is being given to lumber used for joists since shrinkage in these members in houses is objectionable. This study is being carried on cooperatively with the Oregon Forest Products Laboratory, Corvallis, Oreg., the West Coast Bureau of Lumber Grades and Inspection, and several sawmills and lumber-producing companies.

Kiln drying for the laminating industry. The laminating industry, important in this region, glues dry boards and dimension into structural members. This industry, however, is interested in the use of common grades of Douglas-fir lumber at moisture contents below the 18- to 20-percent level. Currently, considerable laminating is being done using lumber dried to 12- to 14-percent moisture content to avoid further shrinkage and deep checking in the glued laminated members when put into use. Fall-down in the grade of the lumber due to damage to knots is of minor importance to this industry since the wood members are designed to omit glue bond and structural strength at knot areas.

Laminators are interested in having sawmills dry lumber to their moisture requirements.

Dry kiln course. Improved kiln drying practice in the lumber industry continued as a major project of the Forest Utilization Service unit. Assistance was given the Oregon Forest Products Laboratory in conducting a one-week dry kiln course in August. The Madison Forest Products Laboratory also cooperated by contributing the time of an instructor. Twenty-six members from the lumber-producing and dry-kiln equipment manufacturing industries were in attendance. Several companies have enrolled representatives on succeeding years which indicates that they appreciate the value of this type of training. A similar course is planned for 1953.

Seasoning foreign hardwoods. Seasoning work has until recently been confined primarily to species of wood grown in this region. However, the increasing importation of hardwood logs and lumber from the Philippine Islands presents new problems. Technologists of the Forest Service as well as of the Oregon Forest Products Laboratory are developing laboratory information on seasoning these new species.

Laminated Structural Products

Laminated boat parts. The volume of structural laminated wood products produced by gluing dry lumber has expanded very appreciably during 1952. Most of the production continued to be for interior use where the material was protected from moisture but there was also an appreciable production of glued material using water-proof resin glues. A considerable volume of laminated boat parts was produced for U. S. Navy mine sweepers. Specifications for these parts require white oak, which is decay resistant, and water-proof glues. Currently, white oak must be brought in from the southern and eastern parts of the United States since no local supplies are available. Most of the oak grown in Oregon and Washington is not very decay resistant and, therefore, would not be suitable for boat parts without some type of preservative treatment. The Forest Products Laboratory at Madison is making studies to see if preservative-treated lumber can be glued successfully. If such processes prove practical, it may be possible to put local oaks to new uses.

During the past year the Forest Service gave assistance to both the Navy and the laminators with their gluing problems. The boat-building industry in this region is becoming acquainted, for the first time, with the advantages which the glued laminated process offers in the furnishing of structural boat parts.

Service records. The Forest Utilization Service unit is collecting data which are used in developing a service record on the performance of glued laminated wood members, particularly bridges, which are exposed to the weather. This information is forwarded to the

Forest Products Laboratory where it is included in the Nation-wide service tests which that laboratory is sponsoring.

Paint Performance on Housing

Along with the rest of the United States the Pacific Northwest continues to experience problems in the maintenance of the paint coating on houses. The Forest Products Laboratory sent one of its staff to make a survey of the problem in this area during 1952. Subsequently, the Laboratory has been studying how moisture enters wall siding construction under climatic conditions such as those found in the Pacific Northwest. These studies indicate that there is more risk from wind-driven water entering walls than is commonly believed. Tests show that rain has rather easy movement through ordinary lap siding by a combination of wind and capillary action. Laboratory studies include testing modifications of the type of joint and types of pre-priming to reduce the moisture entry hazard. Lumber and paint industries are cooperating in supporting these studies.

Log and Lumber Grade Studies

Log and lumber grades are urgently needed for western hardwoods. Small quantities of the species have been cut in the past and have been found to have properties well adapted to furniture manufacture and similar uses. The use is being expanded but there are no standard grades for either logs or lumber which can be used as a basis for buying or selling and this hinders their use. During the summer of 1952 the Laboratory cooperated with the Oregon Forest Products Laboratory on the first portion of a hardwood log and lumber grade study. Since alder is the most plentiful western hardwood it was decided to run studies at two mills cutting this species. Logs were graded by hardwood log rules developed by the Laboratory for eastern and southern hardwoods and the lumber was graded by the National Hardwood Lumber rules. Field data collected are now being computed and analyzed by the Oregon Forest Products Laboratory and a report will be released during 1954. From preliminary information, it appears that the lumber can be graded by the National Hardwood Lumber rules. However, it may be necessary to modify the log rules slightly to meet local conditions. Similar studies are needed for the other local hardwoods such as the oaks and maple.

No new softwood lumber grade studies were started during the year although data collected in previous years were used for two station research notes and for one trade journal publication. The first two reports on the Douglas-fir Peeler Log Grade Study were released. This study is a cooperative project started in 1949 by the Forest Products Laboratory at Madison and this station. The primary purpose of the study is to devise methods to more closely correlate the outward appearance of logs with the quality of the veneer they will produce.

Double Diffusion Tests

The first large-scale test in this region of the double diffusion preservative treatment was made last summer. This new method, developed by the Forest Products Laboratory, appears to be well adapted for farm use. It is easier to apply and cheaper than most methods now in use. Barrels or other containers for holding the solution, water, and chemicals are the only materials needed. The wood is treated while still green, using a combination of chemicals that are soluble in water but when mixed form an insoluble toxic precipitate in the wood. Long-time service records on this method are not yet available. However, a small number of treated posts set out 11 years ago in the Forest Service Mississippi test plots show results comparable to similar material pressure treated with creosote.

The Madison Forest Products Laboratory, the Forest Utilization Service unit, the Deschutes Research Center, the Oregon Forest Products Laboratory, and the agricultural experiment stations of Oregon and Washington cooperated in various phases of the large-scale study undertaken in this area last summer. Tests were made for conditions found on both sides of the mountains, using species most plentiful in the area.

On the west side of the Cascade Range hop poles of split cedar have been used by the hop growers in the past but the supply is becoming inadequate and growers have been attempting to use other species. Douglas-fir from young stands appears to be a good possibility except that young timber contains a high percentage of sapwood and will not last long unless treated. As a part of this study 75 Douglas-fir poles were treated at Corvallis by the double diffusion method and set out on the Oregon State College Experimental Farm. Check poles of untreated Douglas-fir and split cedar were also included for comparative purposes. Also, at Corvallis, 225 Douglas-fir and alder posts were treated by the double diffusion method. These posts were set out in the Starker Post Farm. If the treatment proves to be practical, it will open up a new market for thinnings from young Douglas-fir stands and for the small upland alder.

On the east side of the Cascade Range large amounts of posts are needed for the irrigated farms that are now being greatly expanded. At present, steel posts and those of split cedar hauled in from the west side of the mountains are used. Both are expensive and there is a need for finding some economical method of utilizing local species. Lodgepole pine is abundant in the area but it is very low in resistance to decay. If the double diffusion treatment proves practical, the procurement of posts for east-side farms will be greatly simplified.

To test this species a series of posts were treated at the Pringle Falls Experimental Forest and set out in soil conditions conducive to decay. One set was placed at the Forest Service nursery at Bend, another was sent to the Starker Post Farm at Corvallis, and the third was sent to the Irrigation Experiment Station maintained by the State College of Washington at Prosser, Wash.

Various combinations of chemicals and treating times can be used. The above tests included soaking the wood one day in one solution and two days in another, using such combinations as copper sulfate and sodium chromate in one, and sodium fluoride and copper sulfate in another series.

A technical note which will give instructions on mixing the chemicals and recommendations for treating schedules will be released soon by the Forest Products Laboratory.

Cooperation

During the year the FUS unit maintained active cooperation with private, State, and other Federal agencies doing research work on wood utilization. Several projects were undertaken with the Oregon Forest Products Laboratory and the two agricultural experiment stations in the region. The Forest Service is represented on the advisory committees of both the Oregon Forest Products Laboratory and the Washington Institute of Forest Products. This arrangement makes it possible to correlate the work of different agencies and it also offers an excellent opportunity for disseminating the results of research into channels where they can be applied to commercial problems and production.

Plans for 1953

Work of the Forest Utilization Service for the coming year should be approximately the same as in the past. Working relations between industry, the Forest Products Laboratory, and other institutions doing research in wood utilization will be maintained as in the past. Major emphasis will be given to the following projects:

1. Kiln drying of second-growth Douglas-fir lumber.
2. Utilization of western hardwoods for pulp and lumber.
3. Utilization of mill residues for the production of hardboard and pulp.
4. Laminating and uses for laminated material.
5. Utilization of cull old-growth Douglas-fir logs.
6. Douglas-fir log grade study.
7. Utilization of associated species for fruit and vegetable containers.
8. Improvements in logging and manufacturing equipment and methods.

RANGE RESEARCH

Summer range problems of the Pacific Northwest continued to receive the main attention of the Division of Range Research. This is because: (1) there is a shortage of summer range as compared to the spring-fall ranges and the winter feeding capacity; (2) the production of the summer range can probably be considerably increased through a full improvement program; and (3) the summer ranges are important as watersheds and year-around ranges for game.

Grazing Management Studies

Grazing management studies are emphasized at this station because it is believed that improvement on about 90 percent of the summer ranges in eastern Oregon and eastern Washington can best be accomplished through improved grazing management practices. These studies are centered on the Starkey Experimental Forest and Range and preparation for them has been under way for several years. The study plan was revised and submitted to Washington in 1952. In addition, progress has continued with the installation of physical facilities needed to implement these studies. It is anticipated that the pasture fencing program will be completed in the spring of 1953 in time to stock the pastures in block II for the first year of calibration. The sample plots were laid out in the pastures of block I in 1952, and consisted of 46 clusters within each pasture. A total of 1,932 plots were located and marked during the year.

The value of the grasslands in the management of summer ranges is re-emphasized in data obtained from an inventory of production on one of the experimental pastures. In this pasture the grassland type produced at the rate of 377 pounds of air-dry herbage per acre, as compared to 473 pounds in the forested areas (those accessible to livestock). The difference in herbage production was due almost entirely to the presence of shrubs in the forested areas. These data, converted to grazing capacity, show that the 170 acres of grassland within the pasture provided 39 percent of the grazing capacity, while 340 acres of forested areas provided 61 percent of the grazing capacity. The data also show that a few "key species" within each type are particularly important because they provide the major portion of the forage taken by cattle. For example, in the grasslands 65 percent of the grazing capacity is provided by the grasses, particularly bluebunch wheatgrass, Idaho fescue, and prairie junegrass, while they produce only 19 percent of the total herbage. Sandberg bluegrass, on the other hand, produced 17 percent of the total herbage, but in most years provides less than 5 percent of the forage in the grasslands. In the forested areas, elk sedge is the principal producer of forage, yet it makes up only 11 percent of the total herbage produced there. "Key areas" and "key species" will undoubtedly continue to be useful tools in judging range management practices.

Changes in rate of stocking experimental pastures on block I affected the utilization of grassland species, but had little effect on utilization of species in the forested areas. In 1950 and 1951, the experimental pastures in block I were grazed at a moderate rate of stocking, in an effort to calibrate the true grazing capacity of the pastures. The initial stocking rates in 1950 were based on range survey data collected in 1939 and 1944. Shifts in stocking, made in 1951 to achieve a moderate rate of grazing for calibration purposes, resulted in little change in utilization of species in the forested areas. In the Bally and Horseshoe pastures, previously considered to be understocked, the utilization of bluebunch wheatgrass was increased 15 and 12 percent, respectively. The use of elk sedge and pinegrass in the forested areas showed practically no change under the increased rate of stocking. Similarly, where the utilization of bluebunch wheatgrass was decreased 10 and 22 percent in the Mann and Syrup pastures, formerly overstocked, there was only a 4 percent decrease in use of elk sedge in the Mann pasture, and actually an 11 percent increase in the Syrup pasture. This increase in utilization of the principal species within the forested areas was probably brought about by a change in the distribution of use through better location of salt grounds. These data show that the immediate effects of adjustments in stocking occur chiefly in the grassland openings, and that it is important that grazing management methods be employed to secure proper distribution of livestock use in the forested areas. Much can be done within these areas through judicious location of salt.

Interrelationships of Timber and Forage Production

Good management of ponderosa pine forest range lands in eastern Washington demands optimum production of wood and forage consistent with site potentials. Unfortunately, some pine forest range sites in eastern Washington have more reproduction of pine than is considered necessary for optimum timber production. Range vegetation on such forested range sites is usually very sparse.

Prescribed burning may be one way in which an overstocked stand of seedlings and saplings may be thinned to the number needed to assure best use of the forest and range.

To investigate the value of prescribed burning of overstocked ponderosa pine forests in eastern Washington, the Colville Indian Agency and the station are cooperating in a study on the Pe-el area of the Colville Indian Reservation.

The study is designed and data will be taken to find the effects of prescribed burning of dense ponderosa pine reproduction on the trees, range vegetation, and the soil.

Effect of Pocket Gophers on Reseeded Stands

Pocket gophers may have a strong effect on the rate of improvement and regeneration of established stands of crested wheatgrass in mountain valleys. New plants between the drill rows became established and increased in size four to ten times more readily on study plots where gophers were controlled than where there was no gopher control. Gophers have caused little or no difference in old, established plants of crested wheatgrass, but seem to have a strong effect on stand improvement and regeneration.

Range Condition and Trend Studies

Following the adoption of the three-step technique of observing condition and trend of ranges in 1951, range research personnel have assisted in adapting that method to North Pacific Region conditions, training Forest Service administrative personnel, and in developing standards to use with the three-step method. Particular attention was paid the pine-pinegrass subtype. A tentative list of increaser, decreaser, and invader plants was made up for use in this subtype.

Work was continued in testing improved methods for observing condition and trend for both research and administrative use. An improvement developed for the three-step method assures a consistent and maximum number of observations per transect. Value of this modification is in the effect of increasing the number of observations upon which to base calculations of floristic composition.

Several transects employing the three-step method of observations were established on the Starkey Experimental Forest and Range. In addition, three transects were established in an exclosure on elk range to measure the trend of green fescue range under complete protection. Additional transects will be located in the experimental pastures to be grazed at three different intensities and on the Starkey allotments. These transects should provide a test of the method, under controlled conditions, and the opportunity to interpret experimental results in terms of the three-step technique.

Range Reseeding Studies

Light mulches of sawdust or sheep manure seem to be effective on scab ridges in protecting seedling stands of reseeded grasses from frost heaving. An exploratory study comparing the effects of surface mulches of sheep manure and sawdust with plots heavily treated with commercial nitrogen fertilizer and untreated plots shows plants on the mulched plots to be more vigorous, taller, and more firmly rooted than those on both the nitrogen treated and untreated plots. In the seedling stage there was no wide difference in number of plants (table 1), but many of the plants on the unmulched plots were attached by only one or two hair-like secondary roots.

Table 1.--Numbers of seedlings, average heights, and relative rating on mulched and unmulched plots on a scab ridge

Species	Treatment	No. of seedlings per square foot	Average height (inches)	Relative rating 1/
Pubescent wheatgrass	Manure mulch	2.7	8.0	8
	Sawdust mulch	2.6	7.7	8
	300# nitrogen per acre	4.0	4.4	6
	Untreated	3.0	4.8	5
Timothy	Manure mulch	2.5	4.9	8
	Sawdust mulch	2.1	3.4	7
	300# nitrogen per acre	1.5	2.4	3
	Untreated	1.2	2.2	3
Hard fescue	Manure mulch	2.0	3.3	8
	Sawdust mulch	1.7	2.8	7
	300# nitrogen per acre	3.2	1.5	4
	Untreated	1.8	1.3	4

1/ A rating of "1" indicates a very poor stand; "10" an excellent stand.

Such plants are vulnerable to the summer drought which usually follows the active growing season. Frost heaving has consistently been a major factor in failures to establish stands of grass on shallow, scabby soils of eastern Oregon and Washington.

During the year three new studies were initiated to test the value of sawdust, wood chips, and other soil conditioners, in improving the physical structure and water-holding ability of the soil. One of these studies was on subalpine range land and was designed to test the values of sawdust applied at two rates and disked into the soil. Another study on a scab ridge included the use of wood chips as a mulch, the chips being made at the site by a portable wood chipper. The third study, also on a scab ridge, compares the use of mulches of sheep manure and wood chips with Krilium, a chemical soil conditioner.

Nursery studies reveal that approximately one-third of 140 species and strains tested are adapted for reseeding on the better sites within the forested range areas. These studies, centered in two nurseries, have been going since 1946.

One nursery is located on a reasonably deep, heavy grassland soil, near the timber fringe, on the Starkey Experimental Forest and Range in

northeastern Oregon. Precipitation averages about 18 inches annually, and the elevation is about 3,800 feet. The other nursery is located on a similar grassland soil in the Wenatchee National Forest in eastern Washington at an elevation of 3,000 feet. Precipitation averages from 18 to 20 inches yearly.

While many of the accessions tested are commercially available, others which show promise of some usefulness are in limited seed supply. Table 2 lists the species which through 1951 had made good growth on the nurseries. Many of these are being further tested in field trials.

Table 2.--Forage species which appear adapted for reseeding on good sites within the ponderosa pine zone of eastern Oregon and Washington

Scientific name	Common name	Accession or strain
Group 1 - Rapid-developing, short-lived grasses[1]		
Agropyron caninum	Awned wheatgrass	P-18-1[2]
Agropyron subsecundum	Bearded wheatgrass	P-9115
Agropyron trachycaulum	Slender wheatgrass	P-1711 and P-8039
Arrhenatherum elatius	Tall oatgrass	Tualatin
Elymus glaucus	Blue wildrye	P-792
Phleum pratense	Timothy	5 accessions
Group 2 - Rapid-developing, long-lived grasses		
Bromus erectus	Meadow brome	P-2336
Bromus inermis	Smooth brome	Achenbach and Manchar
Dactylis glomerata	Orchardgrass	7 accessions
Group 3 - Late-maturing grasses		
Agropyron amurense	Amur wheatgrass	P-9838
Agropyron intermedium	Intermediate wheatgrass	P-2327 and P-14
Agropyron repens	Quackgrass	Commercial
Agropyron trichophorum	Pubescent wheatgrass	P-41
Group 4 - Drought-tolerant, long-lived bunchgrasses		
Agropyron spicatum	Bearded bluebunch wheatgrass	P-7845 and P-739

1/ Hafenrichter, A. L., Mullen, L. A., and Brown, R. L. Grasses and legumes for soil conservation in the Pacific Northwest. U. S. Dept. Agric. Misc. Pub. 678, 56 pp. illus. 1949.

2/ Accession or strain numbers are those assigned by the Soil Conservation Service Nursery, Pullman, Wash.

Group 5 - Drought-tolerant, long-lived sodgrasses

Agropyron smithii	Bluestem wheatgrass	P-727

Group 6 - Vernal-dominant, dryland grasses

Poa ampla	Big bluegrass	P-8903

Group 7 - Understory grasses with heavy root production

Festuca ovina duriuscula	Hard fescue	Hard (P-2517)
Festuca rubra	Red fescue	P-252
Festuca rubra commutata	Chewings fescue	Commercial

Group 8 - Wet meadowland grasses

Agrostis alba	Redtop	Commercial
Agrostis tenuis oregonensis	Highland bentgrass	Commercial
Alopecurus arundinaceus	Creeping foxtail	P-111
Alopecurus pratensis	Meadow foxtail	Commercial
Poa compressa	Canada bluegrass	Commercial
Poa longifolia	Longleaf bluegrass	P-417
Poa pratensis	Kentucky bluegrass	6 accessions

Group 9 - Legumes

Medicago sativa	Alfalfa	Ranger, Ladak, Nomad
Vicia tenuifolia	Bramble vetch	P-692

Group 10 - Miscellaneous

Purshia tridentata	Antelope bitterbrush	Native

The nursery trials indicate that representatives of groups 1, 2, 3, and 8 are best adapted for reseeding use in the ponderosa pine zone. Even though the nursery trials have provided many grasses useful for reseeding, there is a real need for finding additional drought-tolerant, long-lived bunchgrasses in the pine zone. In this group, only bluebunch wheatgrass has shown up well.

Pubescent wheatgrass does well under rather adverse conditions and in competition with undesirable vegetation. In very heavy, shallow, rocky soil on Ray Creek Ridge in the Whitman National Forest, plantings of pubescent wheatgrass are continuing to spread by rhizomes, forming an excellent cover. On Coffee Pot Flat in the Fremont National Forest, plantings of pubescent wheatgrass made in 1946 are forming an excellent sod cover, even under heavy grazing use. There is practically no invasion of big sagebrush and rabbitbrush, while these shrubby species have almost completely invaded plots planted to 14 other grass species.

Bramble vetch and Nomad creeping alfalfa are two legumes which show promise of being useful in range reseeding. Bramble vetch is one of the few legumes which have resisted depletion by rodents. It has produced an excellent stand on the Swauk Meadow Grass Nursery and has maintained itself well for five years. A field trial planted in the spring of 1949 yielded 480 pounds of air-dry bramble vetch herbage per acre in 1951. In 1952, although herbage yields were not obtained, the stand appeared to be thickening.

Nomad creeping alfalfa has done especially well on a grassland opening with good, well-drained soil in the ponderosa pine forest type. In 1952, its second growing season, unfertilized Nomad yielded 1,000 pounds of air-dry herbage per acre. In this study, the Nomad was spring-seeded in alternate six-inch drill rows with intermediate wheatgrass. Table 3 shows the herbage yields of both the Nomad and intermediate wheatgrass under different kinds and levels of fertilization.

Table 3.--Second-year herbage yields of Nomad creeping alfalfa and intermediate wheatgrass under different kinds and levels of fertilization

Fertilizer treatment	Yields - pounds per acre, air-dry		
	Intermediate wheatgrass	Nomad alfalfa	Total
Control	570	1,000	1,570
Nitrogen, 40 lb. per acre	460	1,790	2,250
Nitrogen, 60 lb. per acre	780	1,130	1,910
Gypsum, 200 lb. per acre	380	3,310	3,690
Superphosphate, 200 lb. per acre	350	2,050	2,400

A study to extend the knowledge of several possible ways for replacing cheatgrass by good stands of perennial range grasses has yielded worth-while results in central Washington. In the Washington studies, cheatgrass range was treated in several different ways. It was burned in the late spring just after the cheatgrass turned red and before seed shattered, burned in mid-summer after the cheatgrass seed had fallen to the ground, and burned in the late fall after the cheatgrass seed had germinated. On other plots, the cheatgrass was plowed under. Some areas of cheatgrass were left undisturbed. In the fall a mixture of crested and intermediate wheatgrasses was seeded by broadcasting and harrowing, single-disk drilling, double-disk drilling, and deep-furrow drilling on the plots where cheatgrass had been burned, plowed under, or left undisturbed. Other plantings were made on land duckfooted in the spring and summer-fallowed.

The different methods of cheatgrass treatment showed different effects on cheatgrass numbers in the year following the treatment. Plowing reduced cheatgrass the most. Burning in the late spring was next most effective, while burning in mid-summer and in the fall was not effective in reducing cheatgrass. The mid-summer and fall fires did not

destroy enough of the current seed crop, or, in the case of the fall burn, not enough of the newly germinated cheatgrass plants.

Summer-fallowing definitely favored perennial range grasses on some additional planting trials. Numbers of cheatgrass were greatly reduced and moisture was conserved. Good stands of pubescent, Whitmar beardless and intermediate wheatgrasses, and Sherman big bluegrass resulted from fall seeding on summer-fallowed land. Spring plantings of pubescent and Whitmar wheatgrasses and Sherman big bluegrass turned out well on the summer-fallowed area.

Herbage production data on the cheatgrass eradication study in 1952 are of interest, even though the year was a very dry one in central Washington and prevented full production. The high average air-dry herbage yield of 480 pounds per acre was made on plots where the cheatgrass was plowed under in the springs of 1946 and 1947 and intermediate and crested wheatgrasses broadcast seeded in the fall of each year.

Drilling with double-disk and deep furrow drills in seedbeds prepared by burning the cheatgrass in late spring and mid-summer resulted in good mixed stands of intermediate and crested wheatgrass. In 1952, 360 pounds of air-dry herbage per acre were produced on the plots seeded with the double-disk drill, and 350 pounds on those seeded with the deep-furrow drill.

Where intermediate and crested wheatgrasses were seeded directly into undisturbed cheatgrass, less than 40 pounds of perennial herbage was produced per acre in 1952.

Chemical eradication of California falsehellebore may be possible by treatment with 2,4-D over a two-year period. A dense stand of California falsehellebore (Veratrum californicum) has been reduced by 94 percent of its original density in cooperative studies with Washington State College. While it covered 69 percent of the soil surface before spraying in 1950, its density in 1952 was only 4 percent.

The treatment used was four pounds of isopropyl ester of 2,4-D. One application at four pounds was made in 1950 when the falsehellebore was 18 to 30 inches tall with no inflorescences showing. A second application of 2,4-D at four pounds was made on the same plots in 1951 at the same stage of plant growth. The first application was made with water as the carrier at the rate of 60 gallons per acre. In the second application, diesel oil was used as the carrier at a rate of 20 gallons per acre.

Two applications of only two pounds each per acre of isopropyl ester of 2,4-D reduced the density of falsehellebore by 77 percent.

One application each of polybor at one and two pounds per square rod, and polybor chlorate at one and two pounds per square rod did not give significant reductions of falsehellebore.

Big Game-Livestock Relationships

Tentative levels of proper winter use of some important eastern Oregon and Washington shrubs are given by a study concluded in 1952. Winter clipping over a seven-year period of different amounts of current twig production shows considerable variation in the amount that can be removed from different species and still maintain a high level of production. The results suggest that antelope bitterbrush (Purshia tridentata) can be used 60 to 65 percent on good sites and 50 percent on poorer sites; snowbrush ceanothus (Ceanothus velutinus), 35 to 40 percent; rubber rabbitbrush (Chrysothamnus nauseosus), 50 percent; and creambush rockspirea (Holodiscus discolor), 50 to 60 percent. Curlleaf mountainmahogany (Cercocarpus ledifolius) plants whose main crowns have grown out of the reach of grazing animals provide almost no forage after initial removal of the twigs and leaves within their reach. Such tall mahogany plants should be given very little grazing capacity in estimates of sustained forage production.

A study was begun to find ways of increasing the forage supply on ranges used in spring and fall by livestock and in winter by deer in cooperation with the Grant County Stockgrowers' Association, the Grant County Izaak Walton League, the Oregon State Extension Service, and the Soil Conservation Service. To determine the effects of these two classes of animals on the establishment of mixed stands of grasses and bitterbrush, an area totally protected from grazing will be compared with one protected from livestock only, and with one open to grazing by both classes of animals.

Plans for 1953

Building the last of the fences for the Starkey experimental pastures is anticipated in 1953 in time to begin the calibration of the pastures in block II this year. Also, it is planned to cross-fence the pastures scheduled for deferred-rotation grazing in block I, so the treatment of system and intensity can be started in 1954. The sampling system will be laid out in the block II pastures, photo points will be established, and studies of range readiness begun.

Studies will be continued toward developing better techniques and species adapted for reseeding depleted range lands in eastern Oregon and Washington from the low-elevation cheatgrass ranges to the high-elevation subalpine grasslands. Additional studies of reseeding logged-over areas will be started, particularly to determine the relationship between the establishment of grass and the regeneration of stands of pine.

Because the grazing management studies continue to show that grassland openings are key areas in the management of ponderosa pine ranges, a careful analysis of the condition and trend studies will be made to determine which vegetation subtype should receive first attention. Tentative standards have been prepared for the pine-pinegrass

subtype and it may be desirable to move into the grasslands for further work. Testing of improved methods for observing condition and trend on summer ranges will continue.

Publications planned for completion in 1953 include scientific journal articles on fluctuations in production of browse plants; effects of clipping eastern Oregon browse plants; techniques for studying browse plant production; and forage utilization of plant species in different types on the Starkey Experimental Forest and Range. A Department Circular on range reseeding and station research notes on reseeding logging-disturbed areas, construction of log water troughs, and on stock water development are planned. A publication on chemical control of California falsehellebore will be prepared in cooperation with Washington State College. A guide book to the Starkey Experimental Forest and Range will be issued as a station publication.

FOREST MANAGEMENT RESEARCH

Cooperative efforts in forest management research were strengthened during 1952 in a number of ways. Advisory committees at two research centers--Puget Sound and Deschutes--are helping to pinpoint the forest management problems of immediate concern to Federal, State, and private landowners.

Three field meetings at the cooperative experimental forests in western Washington were held by the Puget Sound committee to acquaint members with current research in young-growth forests. Among other activities, the committee launched a special study to develop a standard method for computing growth from permanent yield plot records. This is needed to permit direct comparison of growth information gathered by industrial, State, or college foresters with that of the experiment station.

Late in August a group of 13 Federal, State, and industrial foresters were invited to form an advisory committee for the Deschutes research province. The first organizational meeting was held at Bend in October.

The station's Fire Research Advisory Committee was reactivated at a Portland meeting in June.

Other cooperative regional committees in which Forest Management personnel participated during 1952 included the Rodent Control Committee, the Forest Soils Committee, the Pacific Northwest Christmas Tree Committee, and the Western Forestry Procedures Committee. These groups are helping both in expanding cooperative research and in getting research results into practice.

Cooperative aid from the Publishers' Paper Company paved the way for a special study of windfall in the Oregon Coast Range by personnel at the Cascade Head Experimental Forest. Other cooperative studies that were continued or started during the year included:

1. A prescribed burning study for ponderosa pine on the Colville Indian Reservation with the Office of Indian Affairs.

2. Tests of promising rodent repellents with the State of Washington and the Denver Laboratory of the Fish and Wildlife Service.

3. Fish and game studies at Blue River with the Oregon Cooperative Wildlife Research Unit.

4. Investigations of mistletoe on ponderosa pine and root rot (Poria weirri) on Douglas-fir with the Office of Forest Pathology.

5. A study of animal damage in Douglas-fir plantations on the Clemons Tree Farm in cooperation with the Fish and Wildlife Service and Weyerhaeuser Timber Company.

6. A 2,000-acre pilot plant trial of blister rust control in sugar pine stands on the South Umpqua Experimental Forest with the Bureau of Entomology and Plant Quarantine.

7. The development of a logical classification for forest soils of the Pacific Northwest with Washington State College.

8. Cooperation with Manning Seed Company in establishing seed zones and developing a method for certifying tree seed as to point of origin and climatic requirements.

Assistance was given the regional office of the Forest Service on four special projects:

1. In planning a survey of regeneration and windfall following staggered setting cuttings on "west-side" national forests.

2. Construction of a new lodgepole pine volume table using data from the Colville Indian Reservation and the Chelan and Ochoco National Forests.

3. In planning for the development of a series of seed orchards or cone collection centers to provide improved seed sources for planting or seeding projects.

4. In a study of direct seeding on the Forks Burn area of the Olympic National Forest.

Ten of the station's 11 experimental forests were active during 1952 with timber-growing studies covering four of the region's major forest types--Douglas-fir, spruce-hemlock, ponderosa pine, and the mixed conifers of southwest Oregon. The major findings from these and from special projects in fire, mensuration, seeding and planting, forest soils, and windfall follow.

Planting and Seeding

Efforts to reforest burns, old cutovers and even recent clearcuts in the Pacific Northwest have increased rapidly in recent years. During 1952 some 62,000 acres in Oregon and Washington were planted or seeded by Federal and State agencies and private owners. Interest in reducing planting or seeding costs and in improving survival and growth of tree seedlings is correspondingly high.

The effect of cold storage on survival of planted seedlings was evaluated in a test at Wind River. Seedlings of three species--ponderosa pine, Douglas-fir, and noble fir--were given three treatments as follows:

1. Cold storage in shingle-tow November to April.
2. Cold storage in sphagnum moss November to April.
3. No storage, seedlings left in nursery beds over winter.

The seedlings were planted and records taken on survival through the first growing season. The study showed that cold storage over winter does not exert a significant influence on survival. The Wind River Nursery is able to supply planting stock for late winter or early spring planting at lower elevations only by digging seedlings in the fall and storing them over winter. Further expansion of the nursery and additional investment in cold storage facilities hinged in part on the outcome of the study.

Animal damage in a mixed conifer plantation on the Clemons Tree Farm was found to deform about half of the trees during the first four years. Douglas-fir, western hemlock, and Port Orford cedar had been planted in an area of relatively high populations of deer, rabbits, and mountain beaver. Repeated examinations show that rabbits and deer were responsible for most of the damage. Douglas-fir was the most susceptible species with 70 percent of the trees deformed. Damage was not severe enough to substantially reduce survival, but height growth was restricted.

The encroachment of brush following cutting seriously hinders the establishment of natural reproduction or the survival of planted stock in many parts of the Northwest. The problem is most acute in the fog belt forests along the Oregon and Washington coast where a long growing season and ample moisture favor the rapid growth of a number of aggressive shrubs.

At Henderson Creek, near Florence, Oreg., tests of slash burning and planting (Douglas-fir) were started four years ago as a possible practice for giving the trees a head start. This is an area where salmonberry and associated species form a dense brush cover. Measurements in 1952 showed only a slight difference in survival and growth of planted Douglas-firs in favor of the burned as against the unburned surfaces, even though brush is heavier on the unburned. Natural reproduction is becoming established gradually on both burned and unburned surfaces but is confined to the few small openings. No natural seedlings have started in the heavy salmonberry thickets. It is too soon to draw any final conclusions because the brush is still growing faster than the trees. During the fourth growing season alder also started to seed in on the area and may prove another obstacle to the survival and growth of the plantation.

An analysis of height growth shows that planted trees are making the best height growth where they are one-quarter shaded from direct sunlight by competing brush. Trees not shaded grew about the same as those one-half shaded. As the brush shade increased above 50 percent, however, height growth dropped off rapidly.

Browsing by deer has also been a major factor at Henderson Creek. Undamaged trees grew 20.7 inches in height during the last two growing seasons compared to 14.6 inches for trees browsed once and only 4.2 inches for trees browsed twice. In this case, animal damage could easily spell the difference between success or failure of the plantation.

Another example of brush threat in the coastal zone is the exceptionally dense cover of bracken and salal on part of the Hemlock Experimental Forest, near Hoquiam, Wash. Planting trials of Douglas-fir, Sitka spruce, grand fir, western redcedar, and western hemlock have been started to find which species is best suited to these brushy areas.

One of the most promising developments in the field of direct seeding has been the introduction of tetramine--a combined rodent repellent and rodenticide--by the Denver Laboratory of the Fish and Wildlife Service. Methods for treating tree seed directly without appreciably reducing viability are being worked out for Douglas-fir and ponderosa pine. Many agencies are cooperating in the project. Wind River is helping with necessary germination tests and field trials are under way or planned at Wind River and by the Puget Sound and Siskiyou-Cascade Research Centers. An interesting by-product of a 1952 field test with ponderosa pine at Wind River was the finding that where stratified seed was covered by soil in prepared spots, germination was 83 percent compared to zero germination when the same seed was broadcast on the ground surface. Stratified seed of ponderosa pine is apparently highly susceptible to exposure during short drought periods in the spring and early summer.

The cylindrical "Keyes" screen also shows promise for minimizing both rodent and cutworm damage in direct seeding operations. Trials in the interior of southwest Oregon, using only two seeds per screen, have shown a first-year survival of 78 percent for ponderosa pine and 72 percent for sugar pine. In these tests forest soil or sterile vermiculite was used for preloading the screens and the seed was stratified and treated with a fungicide prior to planting. Conventional seed spotting on the same areas has consistently failed. Ponderosa and sugar pine have proven superior to Douglas-fir in both seeding and planting tests. Poor survival of Douglas-fir is attributed to its failure to rapidly develop a deep root system.

An important part of the station's program in artificial regeneration is the Wind River Arboretum. Adaptability tests for conifers from all over the world have been under way since 1912. Several older groups of pine, including Coulter pine, Apache pine, and mountain pine, were seriously injured or killed outright during a severe and prolonged cold spell in the winter of 1949-50. The abrupt failure of these trees after 20 years of good growth is a striking example of the hazards when introduced species are planted on a large scale without benefit of long-term adaptability trials.

A columnar variety of western juniper was added to the Arboretum in 1952 and small outplantings of corkbark fir were made at seven locations on the national forests to test this species for Christmas tree production. Group plantings of dawn redwood were also established at six points in the fog-belt zone of Oregon and Washington.

Although the station does not have a full-scale program of research in tree genetics, some progress in this important field of work was made in 1952. Isaac gave a paper "Advantages of Selecting Tree Seed With Care" at the Western Forest Nurserymen's meeting in British Columbia and cooperated with the regional office of the Forest Service in the preparation of "A Plan for the Selection of Seed Source Areas and the Development of Seed Orchards on the National Forests."

Looking forward to the time when a genetics program can be activated, four species of Pseudotsuga and several strains of Douglas-fir representing the complete natural range of the species were secured cooperatively with the University of Washington. Group plantings of each have been made at both the Wind River Arboretum and the University's Pack Demonstration Forest. A site for field trials of hybrid pines developed at the Forest Genetics Institute in California has also been prepared at the Pringle Falls Experimental Forest. The first outplantings next spring will compare ponderosa-scopulorum crosses with Jeffrey pine and local ponderosa pine.

Douglas-fir Management

While large-scale premature clearcutting of young-growth Douglas-fir stands continues in western Oregon and western Washington, experimental evidence continues to demonstrate that commercial thinning is profitable, both economically and silviculturally beginning at stand ages of only 30 to 40 years on the better sites. The widespread application of thinning in place of clearcutting would greatly improve the productivity of these young stands. It could also be expected to substantially increase over-all returns to the forest owner.

Growth in thinned stands equals unthinned. Two- and three-year remeasurements of 30- and 40-year stands indicates that removing up to one-third of the cubic volume in thinning does not reduce the growth rate of the stand. In a 40-year stand on the Voight Creek Experimental Forest, growth in at least one of the thinned compartments exceeded the unthinned compartment. In the adjacent 30-year stand at King Creek, average growth after thinning was slightly greater than for unthinned portions of the stand.

Second thinning is cheaper. Cost records at Voight Creek showed that when a 40-year stand of Douglas-fir is lightly thinned for the second time, production per man-hour was 40 percent greater than in the first cutting. Basis of comparison was a 17-acre compartment thinned on a three-year cutting cycle. Lower skidding costs through use of skid roads developed for the first cut, improved crew organization, and more experienced marking on the part of the forester made these cost reductions possible. Practices that help to hold down logging costs are:

1. Remove as large an average-sized tree as is consistent with thinning objectives.

2. Don't skid over 500 feet.

3. Employ small contractors, or pay on a piece rate basis.

Long logs lower thinning costs. On the McCleary Experimental Forest, three years' experience in a 55-year stand of Douglas-fir shows a marked reduction in logging cost when all logs are bucked in lengths of not less than 30 feet and when skidding to the roadside is completed before loading is started. Through these practices man-hour production was increased from 115 board feet in 1950 to 194 board feet in 1952. Corresponding reduction in cost of the entire operation per M board feet was from $25.66 in 1950 to $19.96 in 1952. Thinning removed about 5,300 board feet per acre (or 12 percent) in trees averaging 16.6 inches d.b.h. Principal advantages of this type of logging were:

1. Reduction of skidding time through elimination of delays at "hot" landings.

2. Elimination of loading delays caused by frequent arrival of yarding tractors.

3. No loading delays while waiting for enough logs to make up a load.

4. Use of log trucks at maximum efficiency because faster loading results in more truck loads per day.

More scale in short logs than long logs. The increase in volume by Scribner scale when long logs are bucked and scaled as two short logs was determined from a study completed in 1952. The difference is surprisingly great for the small logs with high taper which are commonly cut from young-growth stands. In a recent sale on the McCleary Experimental Forest the short log scale was found to exceed the long log scale by 20 percent. Scaling tables that will permit a forest manager to accurately and easily compute the scale difference are presented in an article awaiting publication.

Thinning increases yields in 100-year Douglas-fir. At Wind River, two commercial thinnings in 1939 and again in 1952 have been carried out in a stand now 110 years old. The first cut removed 9 M board feet per acre and the second 13 M. A 1952 inventory of both thinned and unthinned stands shows that total yields from the thinned stand (present reserve volume plus volume removed in thinning) totals 72 M board feet per acre compared to a volume of only 63 M for the unthinned stand. This represents a net gain of 640 board feet per acre per year over a 14-year period. A clear-cut final harvest will be made when periodic growth rate drops below an annual rate of 500 board feet per acre. A study of logging scars on the residual trees in the thinned stand showed that trees were most susceptible to scarring during the late spring and early summer when the bark was slipping. Comparatively few scars resulted when thinning was carried out in the fall. Observations on soil damage in the thinned stands indicates that where tractor yarding is used, thinnings should be confined to slopes less than 30 percent.

Harvest cuttings in 100-year Douglas-fir are also under way at Wind River on areas too steep to thin successfully. A comparison of natural regeneration on two staggered settings 10 and 18 acres in size shows that rodent baiting holds promise for increasing effectiveness of natural seed fall. The 1951 cone crop furnished about two pounds of seed per acre on both clearcuts. One was baited just prior to seed fall. Germination and survival were markedly better on the baited area. Seedling counts at the end of the 1952 growing season showed 2,500 Douglas-fir seedlings per acre on the baited clearcut compared to only 400 per acre in the untreated clearcut.

Isaac's report on "Partial Cutting in Old-Growth Douglas-fir" is in rough draft and will be readied for release as a station paper early in 1953. Partial cuttings removing from 15 to 40 percent of the stand

volume were made in a decadent old-growth stand at Wind River in 1949. Annual mortality checks show that the highest losses have taken place in the stands cut heaviest:

Volume removed (Percent)	3-Year mortality per acre (Board feet)
15	536
20	2,585
30	2,958
40	5,524

Average annual loss for all areas averages 967 board feet per acre. There is little evidence here to support the theory that partial cuts in old-growth stands can help to restore them to a productive condition.

Since 1948 most of the studies on management of old-growth Douglas-fir have been concentrated on the Blue River Experimental Forest in the Oregon Cascades. A large-scale test of staggered setting cutting is in progress. Advantages and limitations of the method are being evaluated in terms of logging costs, regeneration, regulation, mortality and windfall, watershed protection, and fish and game production.

A new approach to the planning of an efficient system of permanent logging roads developed in 1951 and 1952 has been used in the layout of nearly 4,000 acres of timber sales at Blue River. A research paper is now in preparation.

When the road system is completed, probably as much as one-quarter of the annual cut for the experimental forest will come from the salvage of mortality on the leave settings. Two exploratory trials of salvage logging on steep ground were made at Blue River during 1952. In one a TD-14 tractor was lowered to benches where it could be operated with little damage to the stand. Down trees as far as 120 feet above and below the bench were yarded to the single tractor trail by using a tag line drawn by hand to the log. From the benches the logs were raised to the main road with a short spar tree and high lead. Rub logs placed against trees along the skidway minimized damage to the residual stand. Costs were about normal except for yarding which cost about twice as much as for conventional high-lead logging. Even so, a margin of $13.40 per M was left for stumpage. The salvage included a large percentage of peeler grades. In a second trial down trees along a steep portion of Lookout Creek were salvaged. A low standard road on good grade was built through the best available ground with little damage to the stand. Logs within 200 feet of the road were then drummed to the road by tractor and yarded to a landing on the road. Logs were loaded with a rubber-tired donkey. Damage to the residual stand and sedimentation from the logging were negligible. Although yarding costs were about one and

one-half times higher than for conventional clear-cutting operations, a margin of $18 per M remained for stumpage. Slopes on both salvage areas were generally steeper than 50 percent.

The importance of varying time of slash burning in years of good cone crops was demonstrated by two clear-cut areas at Blue River. One was burned in late August 1951 prior to the seed fall from a bumper cone crop. The second was burned in late October after seed fall was practically complete. Germination counts in June 1952 showed twice as many seedlings were present where slash was burned before seed fall. Early burning presents a difficult fire control problem because fuels are usually very dry in late August. An alternative would be to burn at the usual time but confine the fire to heavy slash concentrations.

Effects of logging on fish habitat have been studied at Blue River by the Oregon Cooperative Wildlife Research Unit since 1951. Three tentative findings are of special interest to forest managers:

1. Temperatures in small tributary creeks are raised as a result of cutting but the increase seldom exceeds 5° F. A rough calculation indicated that staggered setting cutting, if continued at the present rate, could be expected to increase the temperature in the main stream (Lookout Creek) about one-half of 1° F.--too small a change to influence trout habitat.

2. Ash and charred material entering small streams during and after slash burning were found to increase pH from a normal value of 7.0 to 7.6. This is well within the range of trout tolerance and is not an unfavorable condition. However, chemical changes in streams after slash burning will receive further study.

3. Rapid and extreme change in the biology of small tributaries was observed where siltation resulted from road building and logging operations. In one small stream crossed by tractor logging, a reproducing cutthroat population was eliminated along with virtually all other aquatic life. In all cases where stream siltation was serious, a marked reduction of trout food organisms was noted. Siltation damage from roads reoccurred periodically whenever they were used for log hauling during rainy periods. So far, the main stream has not been disturbed by logging or measurably affected by sedimentation. Further improvement in logging, hauling, and road-building practices will be needed, however, to minimize sedimentation in the tributary streams.

Root rot (Poria weirii) is now recognized as one of the major killing agents in Douglas-fir stands of all ages. Cooperative studies are now under way at both Wind River and Blue River with the Office of Forest Pathology. At Wind River interest centers on the spread of the fungus in 40- and 110-year-old stands, both thinned and unthinned. At Blue River a study was started in 1951 to determine whether root rot from an old-growth stand can hold over in the ground through clearcutting

and slash burning and remain to infect the next stand. If root rot is found to hold over from one tree generation to the next, a change to a less susceptible species than Douglas-fir may be required.

Growth and mortality estimation in Douglas-fir received attention in three 1952 studies. In one, trend of volume (board feet) over age for well-stocked stands was observed to roughly parallel corresponding curves derived from the Douglas-fir normal yield tables. In a follow-up test of several methods of future volume prediction, the one based on this parallel relationship proved superior to four other prediction schemes that have been in common use. The test was made with data from permanent sample plots representing well-stocked stands. Additional study is needed to develop a method applicable to poorly stocked stands.

A second study furnishes information on the mortality losses that can be expected in young, unthinned Douglas-fir forests. Based on 36 of the station's permanent growth plots, it indicates that losses do not vary significantly with stand age and average 83 cubic feet per acre annually between the ages of 26 and 103 years. The relatively large volume losses that normally occur in a natural stand provide one measure of the extent to which ultimate yields of Douglas-fir can be increased through planned commercial thinnings.

Another study based on the same growth plots relates expected mortality in well-stocked 30- to 90-year-old Douglas-fir stands to individual tree characteristics--d.b.h. and crown class. It is intended for use in growth studies based on stand projection and should permit more accurate estimates of net growth for a 10-year forecast period.

Reports on all three studies are now in preparation.

Management of Spruce-Hemlock

Fog-belt forests of Sitka spruce and western hemlock occupy a fairly narrow strip along the coast line of Oregon and Washington but growth records indicate that they are potentially the most productive forests, acre for acre, in the Pacific Northwest. Commercial thinnings are under study in a 50-year-old stand on the Hemlock Experimental Forest, near Grays Harbor, Wash. At the Cascade Head Experimental Forest on the Oregon Coast both commercial thinnings and harvest cuttings are being tried experimentally in a 100-year-old stand.

At Cascade Head information on seed fall over a three-year period is now available for two clearcuts, 18 and 81 acres in size. The variation from year to year was high as shown below:

Year	Sound spruce and hemlock seed on two clearcuts (Number per acre)
1949	786,000
1950	8,600
1951	802,000

Nineteen hundred and forty-nine and 1951 were years of good cone crops; the intervening 1950 crop was very light. Seed fall at Cascade Head starts in late October or early November after the normal slash burning season. If a dry, east wind occurs during this period, large volumes of seed fall in a day or two and disseminate toward the southwest. The remainder of the seed falls more slowly during the prevailing southwest winds and drifts toward the north and east. As would be expected, the smaller clearcut received the most seed, but even on the 81-acre cutting seed supply was adequate for regeneration and well distributed.

Size of clearcut (Acres)	Number of sound spruce and hemlock seed per acre	
	1949	1951
18	908,000	910,000
81	665,000	694,000

During the five years since cutting the 18-acre clearcut has received about 1.8 million sound seed per acre. Some seed were doubtless destroyed by rodents, but many thousands germinated and did not survive. The major factor preventing seedling establishment was a heavy cover of salmonberry and associated shrubs. Partial shading of the seedlings apparently did not inhibit survival and growth. Under heavy brush cover, however, seedling survival was almost negligible. Some seedlings survived in the few small areas of exposed mineral soil but a far greater number became established where the ground was covered with rotten wood and decomposing organic material. An average of 625 seedlings per acre are now growing on the area.

Aspect also showed up as an important factor; 762 seedlings per acre were established on the north slope compared to only 487 on the south slope.

The brush problem following clearcutting is receiving major attention at Cascade Head. Prescribed burning of slash and planting are both under trial as a means of getting a new tree crop started on brush threat areas. The project was expanded during 1952 to include trials of brush spraying with selective herbicides.

Young hemlock stands can be thinned from below. Experience gained on the Hemlock Experimental Forest shows that young hemlock

stands may be thinned economically even when less than 10 cords per acre are removed in a low thinning. Trees cut averaged 11 inches d.b.h., although no tree smaller than 8 inches was marked. Ten percent of the standing trees were damaged during the horse logging operation. The seriousness of this type of damage in terms of decay and defect will be evaluated in future measurements.

Minimum size stick accepted at the pulp mill was six inches. Studies showed that recovery in the trees cut would have been 15 percent greater had all wood been utilized to four inches.

Decay following logging injury in western hemlock and Sitka spruce is the title of a report now being readied for publication as a Department Circular in cooperation with the Office of Forest Pathology. It gives a measure of the incidence of decay following logging injury and further shows that sunscald injury on exposed hemlock and spruce also provides a ready entrance for wood-rotting fungi.

Epicormic branching in Sitka spruce is common when tree boles are exposed to additional light. A new study has been started at Cascade Head to determine the factors that influence epicormic branching, how fast and how big the branches grow and their ultimate effect on timber quality. This information is especially important in determining to what extent spruce-hemlock stands should be opened up in thinning.

Reducing Windfall Losses in Stands of Douglas-fir and Spruce-Hemlock

Severe storms of the last few years have demonstrated positively the importance of windfall as a major cause of mortality in the Douglas-fir region. On the Oregon Coast Range alone, one storm in December 1951 blew down 3.7 billion board feet of merchantable timber.

During 1952, an exploratory study of the pattern of windfall was carried out at Cascade Head and at other locations scattered throughout the Oregon Coast Range to determine management methods that will minimize windfall losses.

Three of the findings are noteworthy:

1. Damaging winds in the Oregon Coast Range are mostly from the south and southwest.

2. For stands that have been undisturbed by cutting, most blowdown occurs on lee slopes.

3. Windfall associated with cutting operations is concentrated along the north and east boundaries of clear-cut settings.

These facts provide firm evidence that wind damage associated with clearcutting can be greatly reduced in the Coast Range by using a modified "progressive strip cutting" system, by minimizing or eliminating exposed north and east cutting boundaries, and by carefully selecting wind-firm cutting lines. A station paper summarizing the results of the study is now in preparation.

A local study of windfall around clearcuts was also made on the Blue River Experimental Forest. In this area windfall showed some similarities and some marked differences from the prevailing pattern in the Oregon Coast Range. Both up-valley and down-valley winds were responsible for major losses. At Blue River concentrations of windfall were further found to be associated with local topographic "wind funnels" which restricted and accelerated wind movement as it left the clearcut. For the Blue River cuttings most of the windfall loss was sustained by understory trees which had not been previously exposed to wind. Of the trees that blew down, three-quarters were western hemlock and western redcedar.

Ponderosa Pine Management

Unit area control, an approach to pine management developed by the California Forest and Range Experiment Station, is under study at the Deschutes Research Center as a possible management tool for use in Oregon and Washington pine forests. Condition classes were mapped during 1952 on a portion of the Pringle Falls Experimental Forest and tentative cutting and cultural treatments have been worked out for each unit. Test cuttings to help determine the advantages and limitations of unit area control are scheduled for 1953.

Pruning studies in ponderosa pine have shown that one-third of the live crown length may be removed with only slight effect upon diameter growth. Removal of one-half the crown length caused a loss of $2\frac{1}{2}$ years growth equivalent in a 10-year period. Heavier pruning reduces growth still more and in addition causes some trees to lose dominance. Where three-fourths of crown length was removed, 22 percent of the trees lost at least one step in dominance classification in 10 years. Only 8 percent of the unpruned trees lost dominance. Other studies by the station have shown that pruning to improve wood quality of ponderosa pine pays if done efficiently and if crop trees are selected carefully. This study shows how it can be done without significant loss of growth. Results of effect of pruning on growth will be published early in 1953.

Thinning in pre-merchantable ponderosa pine has increased diameter growth 30 to 150 percent over a 15-year period. This is one of several findings from a 1952 analysis of long-term records from 25 thinning plots. Height growth also gained slightly but responded more slowly to release through thinning. Evidence now on hand from these combined records shows that the rotation age for saw-timber production can probably be reduced from 180 to possibly 135 years through periodic thinnings.

Preliminary studies of dwarf mistletoe in ponderosa pine were started at Pringle Falls during 1952 in cooperation with the Office of Forest Pathology. Dr. Lou Roth, professor of forest pathology, was made available by Oregon State College to conduct the field examinations. The studies indicated that the main spread of the parasite is from overstory trees to understory trees and that lateral spread through stands of even height is a slow process. Overstory infection sources were not easily recognized since old brooms, especially in lower crown, often proved to be less serious infection centers than the less obvious but more dangerous diffuse infections. At Pringle Falls, a few virulent overstory infections were responsible for severe understory damage over a considerable area. Heaviest infection is directly under the overstory tree, usually within one chain; lighter infections may extend to the windward as much as two chains. Preliminary classification of types of overstory infection and understory infection have been developed. In addition a few trials of selective herbicides to kill mistletoe infection were started. These preliminary studies indicate that it may be possible to control mistletoe indirectly through low-cost silvicultural treatments. Further work is needed.

Growth and yield in a 40-year ponderosa pine plantation on the Rogue River National Forest was measured by the Siskiyou-Cascade Research Center. Located in the Butte Falls Ranger District, the 1912 plantation covers 63 acres of a much larger area burned in 1910. Original spacing was 8 x 8 feet. The 1952 inventory shows an average of 238 trees (6.6 inches d.b.h. or larger) per acre with an average diameter of 9.5 inches and a volume of 1,937 cubic feet per acre. Corresponding figures from the ponderosa pine normal yield tables for the same age and site are 309 trees with an average diameter of 8.6 inches and a volume of 2,280 cubic feet. The study demonstrates that a plantation with a relatively small number of well-spaced trees can produce wood at a rate close to what is considered optimum for ponderosa pine.

Management of Mixed Conifers in Southwest Oregon

The mixed conifer stands of southwest Oregon present a large number of challenging silvicultural, protection, and management problems to forest landowners and administrators. An active program of forest management research was first started in this subregion with the activation of the Siskiyou-Cascade Research Center in 1948. Interest has centered on problems of the mixed fir-pine types of the interior but some attention has also been given to Port Orford cedar mixtures on the coast and to the Shasta red fir type in the high Cascades.

Studies in sugar pine management will be the major project on the recently established South Umpqua Experimental Forest. Some 2,000 acres on the forest were burned over by a ground fire of varying intensity in 1910 and the stand was opened up sufficiently to permit the establishment of reproduction of sugar pine and associated species. Where sugar pine developed in sizable openings, dominants have reached

a height of 70 to 90 feet in only 40 years. Under dense overwood, corresponding heights are only 6 to 10 feet. The area offers unusually good opportunities for investigations of sugar pine management and an informal agreement has been made with the Office of Blister Rust Control for its continued protection. The spread of the rust has been negligible since ribes eradication in 1947-48, but much of the reproduction was already infected at that time. A small trial is now under way to determine whether or not the pruning of limb cankers is an effective measure for saving potential crop trees. A preliminary estimate indicates the proportion of sugar pine in the developing stand can be increased from 45 to 81 percent through a combination of canker pruning and weeding.

Do suppressed sugar pine seedlings respond to release? A partial answer was furnished in 1952 through a study of 19 small seedlings that had been partly or fully released four to nine years ago. Average annual diameter growth at stump height was found to increase from 0.018 inch before release to 0.108 inches after release. Annual height growth averaged 1.6 inches before release compared to 5.2 inches in the third and fourth years following release. Two trees showed an average height growth of 20.8 inches in the ninth year after release, indicating that height growth continues to accelerate for a number of years. Apparently suppressed sugar pines respond very rapidly to release. Further study is needed, however, to determine if all suppressed seedlings are potentially good crop trees.

The first study of commercial thinnings in the pine-fir type of the Rogue River Valley was started last summer in a forest tract on the ranch of State Senator Ben Day. The stand is 80 years old and contains a mixture of sugar pine, ponderosa pine, Douglas-fir, and incense cedar. Ponderosa pine predominates in number of trees but almost half of the dominants are sugar pine. Incense cedar is principally an understory tree. Observations in a wide range of pine-fir mixtures show that sugar pine is characteristically the most rapid-growing species.

Only trees nine inches or larger in diameter could be profitably removed in the thinning. About 40 trees per acre in the dominant and codominant classes were cut and total basal area was reduced from about 70 to 47 square feet per acre. Study plots totaling 1.3 acres have been established in both thinned and unthinned portions of the stand to provide information on growth under both treatments. The area is already being used in demonstrating to other landowners possibilities of commercial thinnings in immature mixed conifer stands.

Natural regeneration of Shasta red fir is under study in a 50-acre clear-cut unit on the Union Creek District, Rogue River National Forest. Ten seed traps were placed across the clearcut to measure seed fall from the heavy 1951 cone crop. Then in 1952 a series of 106 milacre plots were established on the area to study establishment of reproduction. Average seed fall from the one crop was found to be

117,000 seeds per acre. Seedling counts in late summer showed that about 2,300 seedlings per acre, mostly Shasta red fir, had survived the first growing season. Sixty-three percent of the milacre plots was stocked with one or more seedlings; a good distribution of seedlings over the cutting area. Clearcutting in staggered settings may prove to be a satisfactory method of cutting for the highly productive Shasta red fir type. Further confirming studies will be needed.

New Methods in Forest Measurement

To provide Forest Survey growth estimates by counties a regression method was developed using records on net volume and stand age from randomly located field plots. It consists simply of plotting net volume over stand age and computing the least-squares regression line. The slope of this line is then used as a best estimate of the average annual volume growth per acre for all the commercial forest land in the county. The new method has several advantages over the "yield table" method previously used. It eliminates the need for subjective classification of forest lands by broad site and stocking classes. It further allows for abnormal mortality and cull increment and provides an opportunity for estimating growth in old-growth stands which were formerly assumed to be nonproductive.

A second innovation was the use of a new measure of tree "form" in constructing a volume table for lodgepole pine. Tree form was defined as d.i.b. at mid-bole expressed as a percent of d.b.h. Form, d.b.h., and merchantable height were then used as the independent variables in a multiple regression to estimate tree volume by the $\frac{1}{4}$-inch International rule. The method of Schumacher (1933) was followed in the volume table construction. The resultant multiple correlation coefficient (.9998 in terms of logarithms) was highly satisfactory.

Forest Soils

Although the research program in forest soils was not reactivated until July, a start was made on two high-priority projects during the last half of the year.

What effect do slash fires have on forest soils? A preliminary study was started to help answer this question in terms of soil reaction, available plant nutrients, and physical composition. A second step will be to determine the effect of these soil changes on the establishment and growth of Douglas-fir tree seedlings and competing vegetation.

A reconnaissance method for classifying forest soils of the Pacific Northwest was developed in cooperation with Washington State College. It was recognized at the start that fine differences in soil texture and depth are costly to determine and are usually of minor current importance in forest management, forest engineering, and watershed management activities. A classification is needed that will permit

rapid coverage of large forest areas at low initial cost and at the same time lend itself to later refinement and ultimate integration with the standard surveys for agricultural lands. One promising scheme was tried on the Gifford Pinchot National Forest. This classification recognizes broad "land types"--areas of similar geologic, topographic, and surface soil characteristics. All roads on the forest were first traversed and soil types were mapped in place wherever crossed. The general pattern and relationship of soil materials to geologic formation, elevation, and topography were also determined as a part of the field work. Type boundaries were then extended into inaccessible areas by the use of aerial photographs. Although the classification needs further field testing, it is believed to afford a means for obtaining essential forest soil information cheaply and rapidly. Cost of field work on the Gifford Pinchot National Forest is estimated at only one-quarter cent per acre.

Fire Studies

Fire weather, fire behavior, and the effect of slash burning in the Douglas-fir subregion were the three main studies.

1952 was a bad year for escaped slash fires but a favorable year to observe behavior of slash fires under severe burning conditions. During September and October only one inch of rain fell in areas that normally receive five inches. Nevertheless, many slash fires were started in late October because November is usually an exceedingly wet month and it was anticipated that slash would become too wet to burn in a matter of days. The record shows that escaped slash fires in the Douglas-fir subregion alone burned a total of 32,000 acres during the fall of 1952.

Fire research personnel observed and studied as large a number of slash fires as it was possible to reach during the season. They found that some extremely dry logging units were burned safely and successfully, while other slash fires escaped even though they were started when fuels were too wet to permit ready ignition. Burning conditions were extremely variable both between logging units in the same vicinity and from one day to the next. Some south slopes, for example, were just as dry as they ordinarily become during a severe midsummer drought while fuel on adjacent north slopes remained wet from light rains and nightly dews that did not evaporate during the short cool days of early November. By choosing a calm day, using water to prevent flash-overs along the fire line, and by finishing burning before the weather became windy, some logging units were successfully burned despite dry fuels and low humidity. This included some slash areas on south slopes and some on flats or other slopes where fuel was dry enough to ignite readily. In contrast, where fuel was too wet to burn completely, or where firing progressed too slowly, fires often smoldered for several days. Then when strong, dry winds occurred, they were whipped into life and frequently escaping from control raced through green timber. Slash burning operations during 1952 not only caused widespread loss but conclusively showed the need for better information on slash fire behavior and for development of improved techniques of slash burning.

Forecasting burning index. Four methods of forecasting burning index (a day in advance) have been tested in a two-year trial at several ranger districts in the "west-side" national forests. The methods were:

1. Special forecasts for individual stations.

2. Forecasts for broad areas, adjusted to individual stations.

3. Use of monthly, seasonal, or daily averages based on records from previous years.

4. Assumption that tomorrow's burning index will be the same as today's.

The test showed that today's conditions provided the best estimate throughout the season of tomorrow's fuel moisture and relative humidity. Average wind speed based on past records gave the best forecast of daily wind. Although fire-weather forecasts were not found accurate enough to estimate burning index at individual stations, they should, of course, be considered in preparing for expected fire danger because they are the only source of information on weather changes not already evident.

1952 fire weather rated. Ratings prepared for western Oregon and western Washington show that while fire weather was below normal for the spring and near normal for the summer the fall period (September 16-October 31) was the most severe since 1936. Even during November, fire weather continued to follow the extremely dry pattern of 1936. Numerical ratings are based on a combination of rainfall, wind speed, and relative humidity at several key stations in each State. They are used by Federal, State, and private forest protection agencies in comparing fire losses and fire costs during 1952 with those of previous years. Without a measure of seasonal fire weather, such comparisons are difficult to interpret.

Plans for Forest Management Research in 1953

Early in the year, the Wind River Experimental Forest will be attached to the Puget Sound Research Center to strengthen the program of forest management research in western Washington. This move will also help to coordinate the research in young-growth Douglas-fir which has been a major project in both areas.

Efforts of personnel in the Portland office will be directed toward departmental publication of three reports, now in preparation or process of review:

1. Normal yield tables for western hemlock.

2. Decay of western hemlock and Sitka spruce following logging injury. (In cooperation with the Office of Forest Pathology.)

3. Natural reproduction in the Douglas-fir region.

The Portland staff will also give major attention to the development of a plan outlining the genetics research needed for the Douglas-fir region.

At the Puget Sound Research Center, scheduled tests of commercial thinnings will be carried out at McCleary, Voight Creek, Hemlock, and Hood Canal Experimental Forests. A new study on pre-commercial thinnings in young plantations will also be started in cooperation with the Olympic National Forest.

The Deschutes Research Center will continue to give major attention to the management of ponderosa pine. Two station papers, one on thinning in pre-merchantable stands and a second on method of harvest cutting, will be readied for release in 1953. Both are based on long-term records from a series of widely scattered sample plots.

The crew at the Siskiyou-Cascade Center is preparing a manual of available information on the silvicultural requirements of the major species in their area. Increased attention during 1953 will also be given methods of reforesting large areas of old burn now characterized as the "brush fields of southwest Oregon."

The problem analyses and work programs at all three centers are currently being revised and brought up to date so that they will serve as effective working tools in the years ahead.

At the Blue River Experimental Forest, road development and harvest cutting have now progressed to the point where full-time efforts of the crew need to be devoted to detailed studies of regeneration and brush development on the cutovers and of windfall and mortality in the leave settings. Arrangements are being worked out for the transfer of most sale layout and sale administration responsibilities to the Willamette National Forest.

The number one job at Cascade Head will be the completion of a station paper on "Reducing Wind Damage in the Forests of the Oregon Coast Range." An effort will also be made to develop a practical method for carrying out intermediate harvest cuttings in spruce-hemlock stands located on steep topography.

In fire studies attention will be concentrated on three major problems: (1) slash burning in Douglas-fir, (2) behavior of both wild and slash fires, and (3) forecasting and rating of fire weather. A cooperative aid agreement now being worked out with the College of Forestry, University of Washington, is expected to strengthen the soils phase of the slash study. This will involve the laboratory analysis of soil samples from burned and unburned slash areas as well as greenhouse tests of Douglas-fir seedlings grown in the same soils.

FOREST INFLUENCES RESEARCH

Rapid growth of industry and population in the Pacific Northwest has increased the importance of adequate and usable water supplies--for electric power, industrial use, irrigation, domestic use, recreation, fish production, and river navigation. In the face of this need, erosion and site deterioration are unsolved problems on our timber and range lands and floods still menace life and property. New concepts of forest and range management need to be worked out and applied, but progress is being hindered by serious gaps in our knowledge of vegetation-soil-water relationships.

Some helpful information on these relationships is developing from our current job of flood control and river basin planning. As examples, we have data regarding the relation of cover type and land use to soil freezing; amounts of sediment carried by West Coast streams; the influence of fire on erosion; and a start made on a small watershed study to measure the effect of harvesting old-growth Douglas-fir on water yield and quality. These efforts are, of course, mere beginnings in the larger research task of supplying the basic information needed for intelligent watershed management.

We have hopes, though, that 1952 marked the starting point for an aggressive research program in forest and range influences. In August and September, E. G. Dunford of the Rocky Mountain Forest and Range Experiment Station appraised a few of the critical watershed problems in Oregon and Washington. He returned in November on a permanent assignment to follow up on this initial step by developing a complete analysis of the problems and to draw up a plan for a long-time investigative program. We are confident these steps will eventually lead to a sustained research effort.

Plans for 1953

Planning for future research will be the principal activity during 1953. The objective is to develop a realistic program within the limits of the funds likely to be available. Basis for this framework will be a critical analysis and interpretation of watershed problems and the designation of primary points of attack. Specifically, the jobs for 1953 are these:

1. Develop a critical analysis of problems in the yield and regulation of water; maintenance and restoration of water quality; reduction and prevention of erosion; and rehabilitation of critical watershed areas. Specific problems will be pinpointed as to location and evaluated in importance. The result will be a program of research based on problems of highest priority and carried on in areas where the need for answers is most urgent.

2. Invite suggestions and cooperation from groups and individuals who will directly benefit from a program of research directed toward watershed management. Included will be water users--those representing irrigated agriculture, industries, and municipalities. Others concerned with related uses of water and watershed lands are stockmen, lumbermen, and recreationists. Many of these people are sincerely interested in better watershed management and their suggestions and cooperation will be exceedingly helpful in planning a research program in water and soil management.

FLOOD CONTROL SURVEYS

Major efforts of the Flood Control Survey during 1952 were concentrated on coordination and continuation of all flood-control survey work for the Columbia Basin Agricultural Program. This included continuation of the hydrologic analyses, further development of the flood control and the conservation program applicable to forest and range lands, computation of benefits, and preparation of narrative material. All activities are aimed at completion by July 1, 1953, of the basin-wide report and separate reports on 4 of 11 subwatershed areas. All or part of 3 of the 4 subareas are in the territory of this station.

With the discontinuation of the flood-control survey organization in the California Station, responsibility for completion of their assignment on the Willamette subwatershed unit and the rest of western and southwestern Oregon was turned over to this office. Some of the material for the Willamette subwatershed report was completed in rough-draft form.

Advance Studies

Sediment sampling in east-central Washington and northeastern and southwestern Oregon was discontinued the first of June. Summaries of the second season's work showed no changes in trends from those of the first year as reported in Research Note No. 75, November 1951. Checks on the causes of some of the heaviest sediment loads observed showed that yarding logs to a streamside landing was responsible in one case, a headwaters cloudburst flood in another, and rapid snowmelt over frozen ground in a third.

At the Blue River Experimental Forest, modified trapezoidal stream gages were installed in three small watersheds. Record-taking began in August in cooperation with U. S. Geological Survey and the North Pacific Region, U. S. Forest Service. The season was exceptionally dry, and late in October what will probably be a record low flow of long standing was observed. On the smallest (180-acre) watershed, the flow was measured at 0.022 cubic feet per second; there was no diurnal variation recorded. The Lookout Creek stream gage, which measures the flow from the whole experimental forest, recorded 116,000

acre-feet for water year 1951. This amounts to 90.2 inches depth, or an average flow of 6.6 cubic feet per second per square mile. Maximum summer water temperature was 64° F. in mid-July.

The erosion study on the Portland forest park burn showed an average soil loss of 1½ inches depth on 79 observation points for a six-months' period with 32 inches of rain following the burn. Very little rill development was observed. Soil movement was due largely to splash erosion from impact of rain. Though the surface soil was coarse in texture, and infiltration capacity not greatly reduced by the fire, splash and sheet erosion accounted for this very heavy soil displacement on the steep slopes of the area.

Survey Activities

Field work was limited to brief field checks on flood damage data, and to a reconnaissance survey of northeastern Oregon to determine need for and location of flood-control structures in cooperation with personnel of the Intermountain Station.

Most of the survey time and personnel were concentrated on finishing assigned sections of the basin-wide report. Write-ups on physical and biological characteristics of the basin, and on water problems, were finished about on schedule. Some time was also given to the development of the research and surveys parts of the program.

Tabulations of flood damages for the entire basin and each of the 11 sub-basins were finished in cooperation with the Soil Conservation Service. Average annual flood damages are estimated at $16,000,000 for the entire basin. Half this amount is agricultural damage. Only those flood damages which will be unaffected by existing or imminent projects of other agencies were considered.

Data on land ownership and use were organized by counties, States, and subwatershed units. Five broad land-use classes and 10 ownership groupings were recognized. In addition, 8 vegetational cover types were used for forest land, 5 for range land, and 6 for cropland. The entire Columbia River Basin area extends over 176 million acres. Almost half is in forest; about 10 percent is under cultivation. There are 95 million acres administered by various Federal agencies; of these, 54.8 million are in national forests.

The evaluations of range and timber production benefits expected to be realized with the installation of the agricultural program are progressing with the compilation and tabulation of basic data to be used in the determinations. Monetary range benefits are being determined by comparing forage productions in the future with the program and without the program. Timber benefits are being handled in a similar manner.

The hydrologic analysis, relating variation in peak stream flow to changes in watershed cover, was carried on throughout the year. On forested watersheds east of the Cascades, six sources of variation were found to be significant. October precipitation is used to provide an index to soil moisture conditions; total winter precipitation as an index to water accumulation in the snowpack; mean snow period temperature as an index to water losses by sublimation and snowmelt runoff, while spring period rainfall, drainage area, and the area denuded or poorly stocked make up the rest of the list. Highly significant effects for condition of forest cover were also found in analysis of watersheds west of the Cascades in a much different climatic zone. For the hydrologic evaluation of range program effects, summer rain storms were analyzed to determine storm patterns and hourly rainfall intensities. Average I/Pe curves were drawn for storms of various sizes and duration, and are being used with infiltration curves and soil moisture storage capacity data to compute surface runoff.

In cooperation with the Soil Conservation Service, an analysis was made of sedimentation data from a number of reservoirs. Effects of drainage area, rainfall, reservoir storage capacity, and area subject to erosion were found to be significant. Variation in the factor of area subject to erosion will be used to determine program effects on sedimentation.

Cooperation

The division chief was appointed as consultant from the Department of Agriculture for the Interstate Compact Commission, and attended one meeting. This commission includes State commissioners from most of the States in the Columbia Basin and one member from the Federal Government. Its purpose is the negotiation of a compact between the States regarding division, apportionment, and use of Columbia River waters.

The division also has a member in the CBIAC Water Pollution Control Subcommittee, and helped prepare a report on watershed protection for the subcommittee. Some assistance was also given the CBIAC Hydrology Subcommittee in the development of recommendations for a network of sediment sampling stations.

A paper on watershed management was presented to 60 men from the logging industry, the Forest Service, and other interested agencies at the Oregon State College forest soils seminar in November.

For the Bureau of Land Management, division members took part in an inspection of aerial seeding of mustard for soil stabilization on the 1951 Vincent Creek burn in southwestern Oregon. They also helped design a study to determine the effects of the seeding on the regeneration of Douglas-fir. An excellent catch and good growth were observed on this first trial of mustard in Douglas-fir forest areas.

The division also gave direction to a soils study for the Division of Engineering in the regional office. Purpose of the study is to improve specifications for road location, gradient, and drainage according to soil characteristics found on the national forests. A table of culvert spacings recommended according to road gradient, expected rainfall intensity, and soil type has been set up. The work is continuing.

The study design and the grass and legume seed gotten for the proposed Sardine Creek burn tests were given to the Mt. Hood National Forest for use in a similar study on the Lolo Pass power line right-of-way clearing in the Bull Run Division. Our staff took part in the original inspection of the area, and made recommendations for seeding for soil stabilization and to prevent forest regrowth. The seeding was done in September and October, and some germination was observed in November.

Meetings

The division furnished speakers for meetings of various groups. Talks on watershed management and watershed protection were given at the Pacific Northwest Industrial Waste Conference in March, at the Pacific Northwest section meeting of the American Waterworks Association in April, and at the Forest Soils Short Course in November. Talks on the flood-control survey and the Columbia Basin Agricultural Program were given at the Institute of Northwest Resources in June, and at the Northwest Farm Council meeting in September. Another, discussing Senate Document No. 98, was given before the Agricultural Committee of the Wenatchee (Wash.) Chamber of Commerce in June.

One member of the division attended the Western Snow Conference at Sacramento, Calif., in April.

Plans for 1953

Completion by late spring of all program development, evaluation analyses, and report sections assigned to the division in time for preparation of the Columbia Basin Agricultural Program report, and the corresponding subwatershed report for the Willamette Basin, is the major task facing the group. Final due date is June 1953. Other commitments are given second priority. Advance studies will be dropped, or turned over to other interests. Part of the first half of the year will be devoted to revision of the San Diego flood-control survey report.

In the second half of the year, work will be started on the subwatershed reports for western Washington, Oregon Coast, and Yakima-Okanogan units. Considerable field study may be necessary on these jobs, to provide information on land conditions, to locate program structural measures, and to evaluate program effects.

Publications planned for 1953 are:

Some factors affecting sedimentation in the Columbia Basin, by Hobba and Flaxman (SCS). For American Geophysical Union Transactions.

Calculated risk as a factor in watershed planning, by Sartz. For Journal of Forestry.

You can measure erosion easily, by Sartz. For Research Note.

FOREST INSECT INVESTIGATIONS

(Bureau of Entomology and Plant Quarantine
in cooperation with Forest Service)

Blowdown-Bark Beetle Survey

Participation in the cooperative survey of the blowdown-bark beetle situation in Oregon and Washington was one of the major activities of the Portland Forest Insect Laboratory during 1952. (See discussion pages 6-8). Laboratory personnel also expended considerable time and effort in developing techniques used during the survey.

In April 1952 a test was undertaken cooperatively with Weyerhaeuser Timber Company, the Oregon State Board of Forestry, and the Pacific Northwest Forest and Range Experiment Station to determine the feasibility of aerial mapping and counting of trees killed by the Douglas-fir beetle. The results of the experiment showed that relatively untrained men could accurately map and make direct counts of beetle-killed trees over large ownerships from the air. It was found, however, that certain qualifications as to equipment and procedures must be met in order to apply the technique: (1) The airplane must have good forward and lateral visibility, and have a safe slow-cruising speed of 60-70 miles per hour; (2) topographic maps or small-scale aerial photographs of at least 1-inch-to-the-mile scale must be available for the areas to be flown; (3) height of flight above the trees should be kept to a maximum of about 800 feet; and (4) a ground check of each observer's work is necessary in order to establish an air-ground correction factor for the counts of beetle-killed trees.

A second experiment to develop aerial appraisal techniques was undertaken in midspring of 1952. The tests were carried out near Eugene, Oreg., in cooperation with the Pacific Northwest Forest and Range Experiment Station and the U. S. Bureau of Land Management. Results of the tests showed that: (1) Significantly different intensities of blowdown and beetle-kill could be recognized from the air and mapped in place by a single flight over a strip of limited width; (2) a gridiron type of coverage, following predetermined flight lines, was necessary; (3) flight lines should be spaced at intervals of no more than one mile; and (4) the optimum height for best perspective of amount and extent of blowdown was 800 to 1,000 feet above the terrain.

Douglas-fir Beetle Investigations

Studies of the Douglas-fir beetle in Oregon and Washington were initiated in 1946. Investigations to date have been carried out on a variety of ground and aerial photo plots to determine: (1) The extent, amount, and trends of the damage, (2) the types of trees and stands preferred by the beetles, (3) the biology of the insect, (4) the natural control factors of the beetle, (5) the rate of deterioration of

beetle-killed trees, and (6) methods of control or prevention with special emphasis on forest management techniques.

Studies the past season were carried out in cooperation with entomologists and foresters of the Oregon State Board of Forestry and Weyerhaeuser Timber Company. Among the important findings were: (1) The Douglas-fir beetle was in flight as early as March 4 in western Oregon in 1952, (2) a large percentage of the adult beetles that attack trees in the early spring re-emerge to attack for a second time in midsummer, (3) suppressed trees were fairly commonly attacked and killed but rarely produced brood, (4) the foliage on approximately three-fourths of the trees killed in 1951 did not fade until the spring of 1952, (5) natural control agents, particularly clerid beetles and an undetermined dipterous parasite, were found to be exerting considerable pressure on the beetle population in some areas, and (6) deterioration analyses of trees killed the past six years showed complete deterioration of the sapwood after three years and significant deterioration of the heartwood after four years.

Spruce Budworm Control

Aerial spraying for control of the spruce budworm in Oregon and Washington was continued under the administration of the U. S. Forest Service and the Oregon State Board of Forestry with technical guidance by the Bureau of Entomology and Plant Quarantine. Approximately 665,000 acres were sprayed in 1952, making a total of 2,793,000 acres treated during the current outbreak at a cost of approximately $3,000,000. Killing by the budworm has been kept to a very low level throughout the infested area, and epidemic infestation in the Douglas-fir region has been largely eliminated. This has been accomplished in spite of a strong upward trend of infestation on the unsprayed areas.

The following table summarizes the budworm control program to date:

Year	Acreage treated	Percentage of mortality by control units	
		Range	Average
1949	267,000	88.9 - 100	97.6
1950	934,000	90.4 - 100	99.2
1951	927,000	74.0 - 100	98.6
1952	665,000	81.8 - 100	98.2
	2,793,000		

Spruce Budworm Investigations

Studies of the natural control factors affecting the spruce budworm both on sprayed and unsprayed areas in Oregon and Washington were continued in 1952. The emphasis was on evaluating the effectiveness of insect parasites. No evidence of a major decline of the budworm outbreak due to parasitism was found. Accordingly, plans have been made to continue control operations in 1953.

Observations in 1952 showed that the budworm populations on sprayed areas have remained generally low. Appreciable reinfestation has occurred only on small areas where spraying was done too late in the season to be fully effective. Spraying was found to have had no lasting detrimental effects on the parasites.

Annually since 1948, studies have been conducted in Oregon to develop cheaper and more effective methods for controlling the spruce budworm by aerial spraying. These studies have been made cooperatively with private timber owners, chemical companies, the Oregon State Board of Forestry, and the U. S. Forest Service.

In 1952, approximately 10,000 acres on the Mt. Hood National Forest in Oregon were sprayed experimentally to determine whether spraying heights could be raised without seriously reducing the effectiveness of control. The experiment, involving applications at 100 and 400 feet above the timber, was undertaken as part of the effort to insure greater safety for pilots on forest spraying projects. It was a cooperative undertaking by the Beltsville and Portland Laboratories and the U. S. Forest Service. The Beltsville station laid out the project, supervised the field work, analyzed the data, and reported the results. In general the experiment showed that, with the TBM type of airplane, approximately the same degree of kill can be obtained by spraying at 400 feet as with 100 feet.

Forest Insect Survey

The survey of forest insect conditions in 1952 in Oregon and Washington, as in previous years, was a cooperative undertaking participated in by many individuals representing private, State, and Federal organizations. The principal findings by insect species were as follows:

Spruce budworm. Total epidemic infestation decreased from 1,651,000 acres in 1951 to 1,579,000 acres in 1952. However, the area of heavy epidemic infestation increased from 82,000 acres in 1951 to 153,000 acres in 1952. The most encouraging development was the marked reduction of the outbreak in the Douglas-fir region.

Douglas-fir beetle. The special blowdown-bark beetle survey revealed that during 1951 the Douglas-fir beetle killed one billion board feet of timber in western Oregon and Washington. This outbreak is

continuing. In the Blue Mountains area a large and aggressive outbreak was recorded on areas where the trees had been weakened by repeated defoliation by the spruce budworm. The presence of this bark beetle outbreak is complicating the efforts to control the budworm.

Western pine beetle. Epidemic infestations by the western pine beetle, first noted in 1951, continued to develop in 1952. The largest concentrations were found on and near the Yakima and Warm Springs Indian Reservations and the Deschutes, Ochoco, and Fremont National Forests.

Mountain pine beetle. Outbreaks of the mountain pine beetle in lodgepole pine, western white pine, and sugar pine were recorded on a total of 271,000 acres in various parts of the region.

Fir bark beetles. Extensive killing of silver fir in western Washington by fir bark beetles (Pseudohylesinus) has been in progress several years. The outbreak continued at about the same level in 1952.

Hemlock looper. A small but potentially important outbreak of the hemlock looper was discovered on some 2,000 acres in Wahkiakum County, Washington.

Plans for 1953

The work program of the Portland Forest Insect Laboratory has been organized so as to permit an increased amount of research on the Douglas-fir beetle and the spruce budworm, the two insects currently most active in Oregon and Washington. In order to do this, several projects of less importance have been dropped. Much reliance is being placed upon the help of cooperators to carry out the proposed program.

Forest insect surveys and technical guidance of control operations are scheduled on approximately the same scale as in 1952. A special cooperative survey to reassess the blowdown-bark beetle situation is planned. Studies to develop and improve aerial survey techniques will be continued.

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